PRINTED ON THIN PAPER FOR FOREIGN CIRCULATION.

NOV 24 1923

ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND ALEX. RICHARDSON.

OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 35 & 36, BEDFORD STREET, STRAND, LONDON, W.C.2.

VOL. CXVI.—No. 3019.] *LONDON: FRIDAY, NOVEMBER 9, 1923.* [*Registered at the General Post Office as a Newspaper*] [PRICE ... 1s. BY FOREIGN POST 1s. 3½d.

Aveling & Porter, Ltd.,
ROCHESTER.
1108

Steam Road Rollers & Tractors.

A. G. Mumford, Ltd.,
CULVER STREET WORKS, COLCHESTER.
ON ADMIRALTY AND WAR OFFICE LISTS.
ENGINES for Torpedo Boats, Yachts, Launches. BOILER FEED PUMPS.
See Advertisement page 65.
PATENT WATER-TUBE BOILERS. AUTOMATIC FEED REGULATORS.
And Auxiliary Machinery as supplied to the Admiralty. 2179

For Immediate Sale:—
18-in. stroke SLOTTING MACHINE, Table 36 in., by Smith & Coventry.
Twenty Gap Bed S.S.C. LATHES, from 4½ in. to 10 in. centres, hollow spindles; standard makers.
Two Excellent VERTICAL DRILLING MACHINES.
The above machines are all in new condition.
COMBINED PLATE BENDING & FLATTENING ROLLS for 5 ft. by ½ in. plates.
Low prices for immediate clearance.
JOHN H. RIDDEL, LTD., 40, St. Enoch Square, Glasgow. 592

Engineering Salesmanship and SALES MANAGEMENT.—Write for brochure describing our special Course of training for posts of unlimited scope in this lucrative field.—DIRECTOR, Institute of Engineering Salesmanship, 333, Oxford Road, Manchester. 1723

Tank Locomotives.
Specification and Workmanship equal to Main Line Locomotives.
R. & W. HAWTHORN, LESLIE & CO., LTD., ENGINEERS, NEWCASTLE-ON-TYNE. 1138

Spencer-Hopwood & Kirke
PATENT BOILERS. *See page 77, Nov. 2.* 1203
Sole Makers: SPENCER BONECOURT, LTD., Parliament Mansions, Victoria St., London, S.W.

Æ Tubes, Plates, Rods, &c.,
in Brass and Copper.
ALLEN EVERITT & SONS, LTD.,
Kingston Metal Works,
SMETHWICK, BIRMINGHAM. 1344

Jacks
(SCREW and HYDRAULIC).
FELLOWS BROS, LTD.,
CRADLEY HEATH, STAFFS. 9158

Steam Hammers (with or without guides), Hand-worked or self-acting TOOLS for SHIPBUILDERS & BOILERMAKERS. 1189
DAVIS & PRIMROSH, LIMITED, LEITH, EDINBURGH.

Bever, Dorling & Co., Ltd.,
BRADFORD.
HIGH-CLASS ENGINES FOR ALL PURPOSES, also WINDING, HAULING, AIR COMPRESSING and PUMPING ENGINES. 1896

GOLD MEDAL-INVENTIONS EXHIBITION-AWARDED
Duckham's Patent Suspended
WEIGHING MACHINES—EAST FERRY ROAD ENGINEERING WORKS COMPANY, LTD., LONDON, E.—Hydraulic Cranes, Grain Elevators, &c. See illus. Advt. last week, page 15. 1715

CRANES. All Types.
GEORGE RUSSELL & CO., LTD., Motherwell. 1137
Telegrams:—"Cylinders," Birmingham.

Weldless-Steel Tubes
for Water-tube Boilers, Superheaters, Stafting, Hydraulic Work, Boring Rods, &c.
TUBES LIMITED, BIRMINGHAM. 08179

YARROW & CO. (1922), LTD., GLASGOW.
PASSENGER AND CARGO STEAMERS.
SHALLOW DRAFT VESSELS. 1552

Campbells & Hunter, Ltd.
SPECIALISTS IN
Drillers & Boring Machinery
for Engine Works and Boiler Shops.
DOLPHIN FOUNDRY, LEEDS. 4547

VOSPER & CO., LTD.,
PORTSMOUTH.
SHIP & LAUNCH BUILDERS, Od 3551
ENGINEERS & BOILER MAKERS.

Cochran MULTITUBULAR AND CROSS-TUBE TYPES **Boilers**
See page 17, Nov. 2. 1134

The Mitchell Conveyor and
TRANSPORTER CO., LTD.,
CONTRACTING ENGINEERS.
DESIGNERS and BUILDERS of all Classes of HANDLING MACHINERY.
Atlantic House, 45-50, Holborn Viaduct, London, E.C. 1.
Telegrams: "Micontraco, Cent, London." Telephone: Holborn 3623. 1713

The Glasgow Railway Engineering Company,
GOVAN, GLASGOW. LTD.,
London Office—13, Victoria Street, S.W.
MANUFACTURERS OF
RAILWAY CARRIAGE, WAGON & TRAMWAY WHEELS & AXLES,
CARRIAGE & WAGON IRONWORK, also CAST-STEEL AXLE BOXES. 1234

RAILWAY AND TRAMWAY ROLLING STOCK.
Hurst, Nelson & Co., Ltd.,
THE GLASGOW ROLLING STOCK AND PLANT WORKS, MOTHERWELL. Od 3383

P. & W. MacLellan, Ltd.,
CLUTHA WORKS, GLASGOW.
MANUFACTURERS OF
RAILWAY CARRIAGES AND WAGONS
OF EVERY DESCRIPTION.
RAILWAY IRONWORK, BRIDGES, ROOFING, &c.
Chief Offices: 129, Trongate, Glasgow. Od 3547
Registered Offices: Clutha House, 10, Princes St., Westminster, S.W.1.

See's Patent Hydro-Pneumatic **Ash Ejector**
Great saving of labour. No noise No dust. No dirt. Ashes discharged 20 ft. clear of vessel.—Apply, F. J. TREWENT & PROCTOR, LTD., Naval Architects and Surveyors, 43, Billiter Bldgs., Billiter St., London, E.C. Od 4535

Penningtons, University
TUTORS, 284, Oxford Road, Manchester. Estab. 1876. Enrol now for L.C.E. and I.M.E. Postal Courses. 100 per cent. passes last Exams. Reinforced Concrete—a new comprehensive course under expert engineer, £3 3s. Write for particulars. 1711

Iron and Steel
Tubes and Fittings.
Sole Licensees in Great Britain for the manufacture of "Armco" Rust and Corrosion Resisting Iron Tubes. 817
The Scottish Tube Co., Ltd.,
HEAD OFFICE: 34, Robertson Street, Glasgow.
See Advertisement page 71.

Royles Limited,
ENGINEERS, IRLAM, MANCHESTER.
FEED WATER HEATERS, CALORIFIERS, EVAPORATORS, CONDENSERS, AIR HEATERS, STEAM and GAS KNITLESS, } Row's PATENTS.
Merrill's Patent TWIN STRAINERS for Pump Suctions.
SYPHONIA STEAM TRAPS, REDUCING VALVES
High-class GUNMETAL STEAM FITTINGS.
WATER SOFTENING and FILTERING. 5723

IRON & STEEL
Tubes AND Fittings AND Steel Plates.

STEWARTS AND LLOYDS, Ltd.
GLASGOW - BIRMINGHAM - LONDON.
See Advertisement, page 91. 1111

Drag Line Excavator.
Has moved 2,000 cube yards in one day. May be seen at Frodsham, near Chester. Reach 77 ft.; lift four to five tons; speed of working, one to three cuts a minute.
HARRY FAIRCLOUGH, Contractor, WARRINGTON. 1550

Guillotine Shears and Power Presses
FOR SHEET AND PLATE WORKING.
THE REGENT SHEET METAL MACHINE TOOL CO., LTD., REGENT WORKS, WAKEFIELD. 1668

ON ADMIRALTY LIST.
John Kirkaldy, Ltd.,
London Office: 101, LEADENHALL ST., E.C. 3.
Works; BURNT MILL, near HARLOW, ESSEX.
Makers of
Evaporating and Distilling Plants.
Refrigerating and Ice-making Machinery.
Feed Water Heaters.
Evaporators.
Fresh Water Distillers.
Main Feed Pumps.
Combined Circulating and Air Pumps.
Auxiliary Surface Condensers.
&c., &c. 1586

E. J. Davis, M.I.Mech.E., Gas Engines Inspected, Tested and Reported upon. Over 25 years' experience. Tel.: Maryland 1736 & 1737. Wire: "Rapidising, London."—Great Eastern Road, Stratford, E. 15. 1794
THE GLASGOW ROLLING STOCK AND PLANT WORKS.
Hurst, Nelson & Co., Ltd.,
Builders of RAILWAY CARRIAGES, WAGONS ELECTRIC CARS, and EVERY OTHER DESCRIPTION OF RAILWAY and TRAMWAY ROLLING STOCK.
Makers of WHEELS and AXLES, RAILWAY PLANT, FORGINGS, SMITH WORK, IRON & BRASS CASTINGS. PRESSED STEEL WORK OF ALL KINDS.
Registered Office and Chief Works: Motherwell.
London Office: 14, Leadenhall Street, E.C. Od3383

DAVID BROWN & SONS (Hudd.) Ltd.
Lockwood Huddersfield.
HIGH CLASS
Machine Cut Gearing
FOR EVERY PURPOSE. 1440

GEARS OF EVERY DESCRIPTION.
Spring Grove,
AUTOGEARS (LEEDS), LTD., Hyde Park Road, Leeds. 1743

Carels Diesel & Steam Engines. 1120
CARELS DIESEL & STEAM ENGINES (LONDON) LTD., Kinnaird House, 1, Pall Mall East, S.W. 1.
Telephone: Regent 3484.

YARROW & CO. (1922), LTD., GLASGOW.
LAND AND MARINE
YARROW BOILERS. 1553

John Bellamy Limited,
MILLWALL, LONDON, E.
GENERAL CONSTRUCTIONAL ENGINEERS. 1316
Boilers, Tanks & Mooring Buoys
STILLS, PETROL TANKS, AIR RECEIVERS, STEEL CHIMNEYS, RIVETTED STEAM and VENTILATING PIPES, HOPPERS, SPECIAL WORK, REPAIRS OF ALL KINDS.

Head, Wrightson & Co.,
LIMITED.
See Advertisement page 58, Nov. 2. 2402

Special.
TWO HUNDRED HOME and FARM LIGHTING SYSTEMS—New—Complete with battery jars and wire connections of a standard American make—fully guaranteed by well-rated manufacturer. Offered at one-half manufacturing cost for special reason. Packed for export. F.A.S., New York. INQUIRIES INVITED for all or part.
G. ALLEN REEDER, INC.,
220, West 42nd Street,
New York City. C 97

Railway Switches and Crossings.
T. SUMMERSON & SONS, LIMITED, DARLINGTON. 1312

For Your Repairs or any SPECIAL MACHINERY, try THOMAS HUNT & SONS, Albion Ironworks, Bridge Road West, Batterses, S.W. 11. Est 1854. 1642

WAYGOOD OTIS LIFTS 1415
54 & 55, FETTER LANE, LONDON, E.C. 4.
69 & 63, LIONEL STREET, BIRMINGHAM, and Principal Provincial Cities and Abroad.

HEAT INSULATION.
CELITH PRODUCTS CORPORATION, Windsor House, Westminster, S.W.1. 1678
See our Illustrated Advertisement, Oct. 12.

Petter Oil Engines.
For Paraffin and Crude Oil
Sizes 1½ B.HP. and upwards
Petters Limited, Yeovil.
Sizes 25 to 500 B.HP.
Vickers-Petters, Ltd., Ipswich
See advertisement alternate weeks. 9335

Centrifugals.
Pott, Cassels & Williamson,
MOTHERWELL, SCOTLAND.
1676
See half-page Advertisement, page 74, Oct. 26.

The Manchester Steam Users' ASSOCIATION.

For the prevention of Steam Boiler Explosions and for the attainment of Economy in the Application of Steam. 9, MOUNT STREET, MANCHESTER.

Chief Engineer: C. E. STROMEYER, M.I.C.E.

Founded 1854 by Sir WILLIAM FAIRBAIRN.

Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers inspected during construction. 1311

PATENTS AND DESIGNS ACTS, 1907 & 1919.

Notice is Hereby Given that

PERCIVAL WADDAMS PETTER, of West Park House, Yeovil, Somerset, British Subject, and Petters Limited, of Westland Works, Yeovil, Somerset, a Company incorporated under the laws of Great Britain and Ireland, seek leave to amend the Specification of Letters Patent No. 203524, entitled "Improvements in means for heating the vaporisers of internal combustion engines of the Semi-Diesel, Hot bulb, or Surface Ignition Type, and for securing ignition when the engine is first started."

Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents), issued on the 31st October, 1923.

Any person, or persons, may give notice of Opposition to the Amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton Buildings, London, W.C.2, within one calendar month from the date of the said Journal.

W. TEMPLE FRANKS,
Comptroller-General.

C 86

The Greek Legation Begs to

Notify all those whom it may concern that the CONSTRUCTION, UPKEEP, and EXPLOITATION of the PUBLIC WORKS for the WATER SUPPLY of the Towns of Athens and the Piraus, including their suburbs, are being put up for INTERNATIONAL COMPETITION.

All Tenders and Plans must be lodged with the GREEK MINISTRY OF COMMUNICATIONS, Director of Public Works, Athens, by Noon, March 1st, 1924.

The competition in question refers to a concession of exclusive rights for the aforesaid works during a period of 65 years.

Full particulars of the proclamation and terms of the competition in question for these works can be obtained, and plans consulted, by all those interested, at the Greek Legation, 51, Upper Brook Street, W. 1, between the hours of Twelve and One p.m. and 3 30 and Five p.m.

"The present population of Athens and Piraeus totals 560,000 inhabitants and is estimated as likely to increase to 1,100 000 in twenty years time.

2nd November, 1923. C 112

Correspondence Courses for

Inst.Civil Engrs., Inst.Mech.E., London Univ. (Matric., Inter., B.Sc.), and All ENGINEERING EXAMINATIONS personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours), Assoc. M.Inst.C.E., M.R.S.I., F.R.S.A., etc., Also Day Tuition in Office. Excellent results at all Exams. Courses may commence at any time, and all Students receive individual tuition.—For full particulars apply to 8/11, TRAFFORD CHAMBERS, 58, SOUTH JOHN STREET, LIVERPOOL. 1295

TENDERS.

STATE ELECTRICITY COMMISSION OF VICTORIA.

Tenders are Hereby

Invited for the SUPPLY, DELIVERY, etc, of the following for the Morwell Power Scheme.

Copies of Tender Form and Specification will be available upon application to:—

AGENT GENERAL FOR VICTORIA,
Melbourne Place, Strand,
London, W.C. 2.

SPECIFICATION No. 24/2. — TRANSFORMERS, SWITCHGEAR AND ACCESSORIES, SUB-STATION "B."

CHARGE:—£2 2s. for the first three copies of Tender Form, Conditions of Contract, Specification and Drawings complete. This charge will be returned on receipt of a *bona fide* Tender. A fourth copy and any further copies will be supplied for the sum of 10s. 6d. each. This charge is not returnable.

PRELIMINARY DEPOSIT:—A Preliminary Deposit of £100 is to be lodged with Tender. The Specifications may be inspected at the above mentioned office. The Commission does not bind itself to accept the lowest or any Tender. Tenders on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than Noon, 19th January, 1924.

R. LIDDELOW,
Secretary.
State Electricity Commission of Victoria,
Melbourne, Victoria,
Australia. B 951

TYNE IMPROVEMENT COMMISSION.

20-TON HYDRAULIC CRANE WITH ACCUMULATOR AND ELECTRICALLY DRIVEN FORCE PUMP.

THE TYNE IMPROVEMENT COMMISSIONERS are prepared to receive

Tenders for the Construction

and DELIVERY at their Repairing Yard, Howdon-on-Tyne, of ONE 20-TON HYDRAULIC CRANE, with Accumulator and Electrically-Driven Force Pump.

Copies of the Form of Tender, Conditions of Contract, General Specification and Plan, may be obtained on application to the undersigned on payment of a deposit of £1 which will be returned on receipt of a *bona fide* Tender.

Tenders, in sealed envelopes, endorsed on the cover "Tender for 20-Ton Hydraulic Crane," must be addressed to the undersigned and delivered to him not later than Noon, on Friday, the 30th day of November, 1923.

The Commissioners do not bind themselves to accept the lowest or any Tender.

BY ORDER,
RICHARD AUGHTON,
General Manager.

Tyne Improvement Commission Offices,
Bewick Street,
Newcastle-upon-Tyne.
7th November, 1923. C 107

The Director-General,

India Store Department, Branch No. 16, Belvedere Road, Lambeth, S.E.1, REQUIRES:—

1. COPPER WOVEN WIRE SHEETS.
2. DOG SPIKES.
3. TYRES for Railway Carriages and Wagons.
4. AXLES for Locomotives.
5. BRIDGEWORK.
6. STEEL TUBES FOR BOILERS AND SUPERHEATERS.

Tenders due on the 23rd November, 1923 for Nos. 1 to 4, and on the 29th November, 1923 for Nos. 5 and 6.

Tender forms obtainable from above. C 99

FOR SALE BY TENDER. November 21st, 1923.

By Order of N. W. WILD, Esq., Receiver for Debenture Holders.

Tenders are now Invited

for the ASSETS of the
LONDON FOUNDRY COMPANY LIMITED.
BRIMSDOWN, MIDDLESEX,

comprising the

VALUABLE FREEHOLD LAND (about 23¼ acres)

and the

EXCELLENT FOUNDRY BUILDINGS
with an area of
53,800 sq. ft.

THE FOUNDRY is equipped with up-to-date appliances including two 10-TON CRANES, three ELECTRIC FURNACES, Core Ovens, Sand Blast Plant, Bench Saws, Lathes, Electric Motors, Laboratory, and Testing Machine, etc. for an output of

200 Tons of Steel Castings per week.

Particulars, Plans, and Conditions of Sale

from

PHILIP LAKE & CO., 66, Victoria Street, London, S.W.1,

or

FORBES & SONS, Solicitors, 19, Mark Lane, E.C.3.

FRANKLIN, WILD & Co., Chartered Accountants, Orient House, New Broad St., E.C.2.

C 102

COUNTY OF LONDON.

The London County Council invites

Tenders for the Supply and

DELIVERY in London of about 3400 tons of STANDARD STEEL GIRDER TRAMWAY TRACK RAILS, LIPLESS TRACK RAILS, and RENEWABLE GUARD RAILS, with fastenings therefore, and, alternatively of about 5100 tons of such rails, with fastenings therefore.

The Drawings, Specification, Bills of Quantities, Form of Tender and other particulars may be obtained on application to the Chief Engineer of the Council, at the Old County Hall, Spring Gardens, S.W.1, upon payment of the sum of £2. This amount will be returnable only if a *bona fide* Tender is submitted and not withdrawn. All particulars may be obtained on application at the Old County Hall, before payment of this fee.

Tenders must be addressed to The Clerk of the Council and delivered at the County Hall, Westminster Bridge, S.E.1, not later than Four p.m. on Monday, 3rd December, 1923. No Tender received after that time will be considered.

The Council does not bind itself to accept the lowest or any Tender.

JAMES BIRD,
Clerk of the London County Council. C 96

COUNTY OF LONDON.

The London County Council invites

Tenders for Two Centrifugal

PUMPS, together with Pipes, Fittings, etc., for the Isle of Dogs Pumping Station, London, E.; each Pump to be capable of delivering 15,800 gallons of storm-water per minute.

Persons desiring to submit Tenders may obtain the Drawings, Specification, Form of Tender, etc., on application to the Chief Engineer at the Old County Hall, Spring Gardens, Charing Cross, S.W.1, upon payment of the sum of £5. This amount will be returnable only if the Tenderer shall have sent in a *bona-fide* Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application, and the drawings specification and other contract documents may be inspected at the Old County Hall before payment of the fee.

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E.1, after Four p.m., on Monday, 26th November, 1923, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

JAMES BIRD,
Clerk of the London County Council. C 105

THE ROYAL BOROUGH OF KENSINGTON.

TENDERS FOR WEIGHBRIDGE.

The Council of the above Borough are prepared to receive

Tenders for the Construction

of a NEW WEIGHBRIDGE of twenty tons capacity at their Wharf in Kensal Road, North Kensington.

Parties wishing to tender must furnish detailed drawings and specifications of the machine to be supplied and the price must include the construction of the necessary pit, all builder's work, and the delivery and fixing of the machine complete.

Tenders, sealed and endorsed "Tender for Weighbridge," must be delivered at the office of the undersigned not later than Four o'clock in the afternoon of Thursday, the 22nd November, 1923.

The Council do not bind themselves to accept the lowest or any Tender.

The Contractor will be required to enter into a written contract, and, if required by the Council, to provide two good and sufficient sureties for the due performance thereof.

Any further particulars can be obtained on application at the office of the Borough Engineer and Surveyor at the Town Hall, Kensington, W.8.

The Contract Deed will be prepared at the expense of the Council.

By Order,
HORACE RAPSON,
Town Clerk.

Town Hall,
Kensington, W.8.
3rd November, 1923. C 103

THE GREAT INDIAN PENINSULA RAILWAY COMPANY,
48, Copthall Avenue, London, E.C.2, invite

Tenders for:—

1. STEEL SPIKES. Fee 10s.
2. SPANNERS. Fee 7s. 6d.
3. SPARE PARTS OF LOCO. ENGINES. Fee 7s. 6d.
4. LAMINATED SPRINGS. Fee 10s.
5. BRIGHT BRASS BARS. Fee 2s. 6d.

Tenders are due by Eleven a.m., on 20th November, 1923. Tender forms obtainable at above address. Fees not returnable. C 118

CITY OF LIVERPOOL.

TRAMWAY MATERIAL.

The Corporation are prepared to receive

Tenders for the Supply and

DELIVERY of various classes of TRAMWAY MATERIAL, as under.

Firms are required to state clearly when making application for the necessary Tender Forms, the name and number of the Schedule for which they desire to be furnished with Tender Form.

Duplicate Forms of Tender for record purposes will NOT be supplied.

Schedule No. 1. Steel Tramway Rails and Fish-plates.
" No. 2. Steel Fishbolts.
" No. 3. Steel Tiebars.
" No. 4. Copper Bonds.
" No. 5. Timber Sleepers.
" No. 6. Steel Spikes.

Tender Forms will be forwarded UPON RECEIPT OF APPLICATION IN WRITING to:—

THE CITY ENGINEER,
Municipal Buildings, Dale Street,
Liverpool.

Latest Date for Receipt of Tenders:—
Ten o'clock a.m. on Friday, the 23rd instant.

WALTER MOON,
Town Clerk.

7th November, 1923. C 119

APPOINTMENTS OPEN.

Works Manager Wanted to

take charge of production in General Engineering Business in London. Must have had similar experience. Testimonials or stamps not required with application.—Address C 91, Offices of ENGINEERING.

Messrs. Newton, Chambers

and Co., Ltd., REQUIRE by 1st January, 1924, a live BRANCH MANAGER to take charge of their Sheffield Depot and Showrooms at Moorhead.

Applicants, who must be salesmen of exceptional ability, must have experience of light castings for the building trade, heating and cooking apparatus. A general engineering experience of cast-iron and constructional steelwork will be an advantage.

Applications, giving full particulars, together with rate of salary and commission suggested, to be addressed, confidentially, to:—

THE GENERAL MANAGER of the Ironworks Dept.,
Messrs. Newton, Chambers & Co., Ltd.,
Thorncliffe Ironworks & Collieries,
Near Sheffield.

The completion of the appointment will be notified in these columns in December. C 80

Wanted, First-Class Man for

Important Executive Position in large Engineering Works. Must be experienced tool maker, with good technical training in modern tool designing for mass production.—Address, EXECUTIVE, WM. PORTEOUS & Co., Advertising Agents, Glasgow. C 18

Assistant Locomotive

SUPERINTENDENT REQUIRED for the FEDERATED MALAY STATES GOVERNMENT RAILWAY for three years, with possible permanency. Salary 400 dollars a month rising by annual increments of 25 dollars a month to 800 dollars a month, plus a strictly temporary cost of living allowance amounting to 10% of salary in the case of a single man, and for a married man 20% of salary. The Government rate of exchange is now 2s. 4d. to the dollar, but the purchasing power of the dollar in Malaya is considerably less than that of 2s. 4d. in the United Kingdom. Free passages, and, if married, for wife and children also, not exceeding four persons beside the candidate selected. Candidates age 26 to 35, must be of good education and have served an apprenticeship as a Mechanical Engineer in a Locomotive Builder's Shops, or, preferably Railway Locomotive Works; and should subsequently have had experience in the Running Department of a Railway, and be well versed in modern steam shed practice and Locomotive operation. A knowledge of carriage and wagon running and maintenance will be an additional advantage.

Apply at once by letter, stating age and particulars of experience, and mentioning this paper, to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W.1, quoting M/12211. C 94

SURREY COUNTY COUNCIL.

HIGHWAYS AND BRIDGES DEPARTMENT.

Applications are Invited for

THE APPOINTMENT OF SECOND ENGINEERING ASSISTANT at a salary commencing at £190 per annum, rising by annual increments of £10 to £290 per annum. The appointment will be terminable by a month's notice on either side, and will be subject to the provisions of the Local Government Officers Superannuation Act, 1922. Applicants should be competent to make surveys, take levels, and assist with Bills of Quantities and Specifications, and preference will be given to candidates holding the Testamur of the Institution of Municipal and County Engineers. Applications in writing, accompanied by copies of three recent testimonials, should reach W. P. ROBINSON, Esq., A.M.I.C.E., County Surveyor, County Hall, Kingston-on-Thames, not later than Monday, the 26th November, 1923.

T. W. WEEDING,
Clerk of the County Council.

County Hall,
Kingston-on-Thames.
27th October, 1923. C 35

The Royal Air Force

REQUIRES SKILLED FITTERS General (for training as Aero Engine Fitters), Fitters Driver Petrol, Electrical Fitters and Power Station tradesmen. Age limits:—Ex-Service men 18 to 30; Non-Ex-Service 18 to 26; highly skilled Fitters up to 35. Ex-N.C.O's up to 38 years (with rank according to trade ability). Pay from 21s. to 66s. 6d. per week, on enlistment, and all found. Allowance for wife and children to men 26 and over.—Write, stating age, or call:—INSPECTOR OF RECRUITING, R.A.F., 4, Henrietta Street, Covent Garden, W.C. 2. B 759

District Locomotive Engineer

REQUIRED for Colonial Railway. Age 28 to 40 years. Must have had railway experience in locomotive running, preferably on Colonial Railway. Commencing salary £700 per annum.—Write, giving particulars and qualifications, to BOX 626, LEATHWAIT & SIMMONS, 34, Throgmorton Street, E.C.2. C 81

Draughtsman Required for

Engineers' London Office for detailing structural and mechanical work for coal, handling plants, etc. Only thoroughly experienced men need apply. State age, experience and salary required.—Address, C 117, Offices of ENGINEERING.

Draughtsman Wanted; only

those with large experience in Colliery Winding, Haulage and other Mining Machinery need apply. State age, experience and wages required.—Address, C 115, Offices of ENGINEERING.

First-class Draughtsman

REQUIRED, experienced in all classes of crane work. Estimating experience desirable. State age, experience in detail, and salary, with copies of testimonials, to CHIEF ENGINEER, STOTHERT & PITT, LTD., Bath. C 68

Draughtsman, Thoroughly

experienced in Mining and Concentration Plants.—Apply, stating experience, age, and salary required, to FRASER & CHALMERS ENGINEERING WORKS, Erith, Kent. C 84

Required, for Large Factory

about 11 miles West of London, an Experienced MECHANICAL DRAUGHTSMAN, accustomed to lay-out of Factory plant and millgearing and conversant with structural steel design.—Applicants should state briefly particulars of training and subsequent service, with dates, together with salary required, to BOX 116, c/o MITCHELL'S Advertising Agency, 1, Snow Hill, E.C.1. C 85

Wanted, Foreman for Tool

Room. Must be good organiser, efficient and capable of Controlling large Staff.—Address, C 106, Offices of ENGINEERING.

Foreman, Mechanical and

Electrical, to take charge of Fitting and Electricians' Shops. Well up in heavy repairs to Mills and Gearing, lathe and shaft work, and three phase A.C. Distribution Transmission and Motors. Only men thoroughly qualified in both branches need apply. State age, experience and wages, and send copies of references to BOX C 378, SMITH'S Bookshop, Corporation St., Birmingham. C 78

Assistant to Boilershop

Foreman REQUIRED by Firm making Dry Back, Loco. type and Portable engine boilers. Should be preferably, man with all-round boilershop experience, good control of men and sound organiser. Good prospects for right man. Applicants should state age, and when disengaged, previous experience, and salary required.—Address, C 108, Offices of ENGINEERING.

SITUATIONS WANTED.

Manager, Engineering

Patternmaking Contract Department, extensive experience in large industrial Patternmaking concerns, Desires Change to wider sphere in above.—Address, C 95, Offices of ENGINEERING.

Engineer Salesman Import-

ing mostly Woodworking Machinery anxious to develop sales, is WILLING TO JOIN as MANAGER Established FIRM desirous of extending or opening up connections in this plant. Turnover over £1000 monthly. First class buying and selling connections with exclusive agencies.—Address, C 121, Offices of ENGINEERING.

Production Engineer Seeks

PROGRESSIVE SITUATION, sound knowledge of Modern Machine Shop Practice, Rate-fixing and Operation Lay-outs—Foundry and Pattern Shop Experience.—Address, C 36, Offices of ENGINEERING.

Young Engineer (24), B.Sc.,

A.C.G.I., educated at St. Paul's, three years at Imperial College of Science and Technology, nine months' shop practice with machine tools and testing. Also has knowledge of Surveying. Drawing Office experience. Preference for Structural Engineering or Locomotive work. War Service, 20 months, Artists' Rifles and R.A.F.

Address, B 794,
Offices of ENGINEERING.

Young Engineer (22) with

National Certificate in Mechanical Engineering and 5 years' shop experience, WISHES to OBTAIN drawing office EXPERIENCE anywhere.—Address, C 111, Offices of ENGINEERING.

Ropeway Engineer, with

several years' experience in the erection and management of Aerial Ropeways, is OPEN for ENGAGEMENT at home or abroad.—Address, ROPEWAY, WM. PORTEUS & Co., Advertising Agents, Glasgow. C 69

Civil Engineer, University

education, Chemical Section, age 30, varied experience, Swedish, Danish, Norwegian, German, English, some French, REQUIRES POSITION, England or abroad.—B 986, Offices of ENGINEERING.

1923.

Force
FITTERS
ero Engin
rical Fitters
limits;—Ra
e 18 to 26;
.C.O's up to
bility). Pay
ment, and all
n to men 26
NSPECTOR
etta Street,
B 749

ngineer
way. Age 28
xperience in
ial Railway.
Write, giving
BOX 926,
rton Street,
C 81

red for
r detailing
al, handling
ed men need
y required.—

; only
in Colliery
Machinery
and wages
NGINEERING.

atsman
ll classes of
e desirable.
salary, with
ENGINEER.
C 68

roughly
oncentration
e, and salary
NGINEER.
C 84

Factory
London, an
GHTSMAN,
ut and mill-
ctural steel
y particulars
with dates,
OX 116, c/o
Snow Hill,
C 85

or Tool
ser, efficient
ff.—Address,

al and
Fitting and
y repairs to
k, and three
and Motors.
oth branches
l wages, and
378, SMITH'S
n. C 78

ilershop
making Dry
ilers. Should
rshop experi-
d organiser.
cants should
s experience,
, Offices of

ED.

eering
Department,
rial Pattern-
wider sphere
NGINEERING.

Import-
nery anxious
JOIN as
of extending
ant. Turn-
buying and
agencies.—
9.

Seeks
sound know-
, Rate-fixing
Pattern Shop
NGINEERING.

, B.Sc.,
three years
nology, nine
tools and
ding. Draw-
r Structural
War Service,

INEERING.

2) with
Engineering
to OBTAIN
e.—Address,

with
erection and
OPEN for
. — Address,
Advertising
C 62

iversity
e 30, varied
an, German.
POSITION,
NGINEERING.

LITERATURE.

The World Crisis, 1915. By the Right Honourable Winston S. Churchill. London: C. H. Thornton Butterworth, Limited. [Price 30*s.* net.]

A very long time will elapse before Mr. Churchill's arguments can be judged in the high court of history. For the moment the ordinary critic can only set out the main heads of the *ex*-First Lord's eloquent and forceful pleading, and see whether the available evidence supports or modifies, or contradicts, his conclusions

His book sets out to prove three things: (i) That he alone, or practically alone, grasped certain principles of war, which, if put into effect, would have assured an early victory to our arms (pages 34 to 50); (ii) that the naval staff at the Admiralty and the Mediterranean command were responsible for the plan of forcing the Dardanelles by a purely naval attack; and that his adoption of the project was no more than a civilian's assent to professional opinion; and (iii) that the naval attack, originally devised by Admiral Carden, would have been successful had it been maintained (pages 254 to 276). Let us then take these pleas in order.

At the end of his second chapter Mr. Churchill sets out his eight guiding principles of war, of which the first is the key to the remainder. "The decisive theatre is the theatre where a vital decision may be obtained. The main theatre is that in which the main armies or fleets are stationed." The two are not necessarily identical; and the theatre in which Great Britain's military strength will always be most effectively exerted, is one in which the fleet and army will act together. These rules, which are a mere repetition of Sir Julian Corbett's teaching, when applied to the situation in January, 1915, pointed to a war plan in which an amphibious offensive was to be the main item. It therefore comes with something of a surprise to find Mr. Churchill, in his first volume, expounding and advocating these very plans of Continental warfare, which he so vigorously repudiates in his second. As far as one can judge (vol. i, pages 58 and 59), Admiral Sir Arthur Wilson did, in 1911, advise a war plan based upon that amphibious strategy which is so embedded in our military traditions. Mr. Churchill supported the general staff in their opposition to it; and drove Admiral Wilson from office soon after. It is very difficult to understand why Mr. Churchill should have viewed the project of launching a combined attack against the German coasts with coldness and disfavour in 1911 and have made it the principal item of his war plan in 1914 (vol. ii, pages 44 and 45).

With regard to Mr. Churchill's argument about the naval attack on the Dardanelles, it is perfectly true that the project was conceived by a naval officer—Admiral Carden—and approved by Mr. Churchill's advisers at the Admiralty; but this does not end the matter. The narrative shows quite clearly, that the unqualified agreement of the naval high command was only given provisionally; and that, after thinking it over, Lord Fisher and Sir Henry Jackson put forward certain very embracing reservations. Mr. Churchill does not attempt to deny that Lord Fisher disliked the whole scheme as soon as he had time to consider it in all its bearings; but, because the First Sea Lord opposed it on general principles (vol. ii, pages 154 *et seq.*), and because he did not attack it by technical arguments, Mr. Churchill argues that he was quite justified in overriding the advice of his chief naval adviser. The claim cannot be accepted as it stands. By general agreement the joint responsibility of the Board of Admiralty no longer existed; a war group was taking all the executive decisions. But if any member of that war group disapproved of the measures taken, no matter whether his dissent were based upon technical or general arguments, there could only be one court of appeal, the Board. The Board of Admiralty never had a chance of deciding on the matters in dispute between Mr. Churchill and Lord Fisher in February, 1915, and therein lies Mr. Churchill's responsibility.

Sir Henry Jackson's reservations were of a different kind; he did not consider the naval bombardment was a sound operation of war unless a strong military force was available to assist in the operation or to follow it up when the forts were silenced. When one looks into events as they actually occurred, one has to admit, that, had those powerful landing parties, which Sir Henry Jackson considered essential to success, been present when the naval bombardment began, it is impossible to say where the naval attack would have stopped. How does Mr. Churchill deal with this awkward *caveat*? He describes it as a piece of confused thinking, and emphasises the difference between assisting in the naval bombardment and following it up (page 179). The truth is that Sir Henry Jackson's minute deals finally with the argument that Mr. Churchill's naval advisers accepted the Carden plan as it stood; and Mr. Churchill's rather contemptuous phrase will not get over the obvious fact that Sir Henry Jackson's wise and far-sighted advice was disregarded.

Mr. Churchill next deals with the intrinsic merits of the naval bombardment. He claims that it would probably have succeeded had Admiral de Robeck persevered. He supports his plea by purely technical facts about the percentage of hits which naval guns can register on forts ashore, and by quotations from certain Turkish and German officers. The first set of arguments have not been balanced by setting out the facts and data upon which engineers base their convictions with regard to the ability of land defences to resist snip fire; and as this has not been done, one has a perfect right to say that Mr. Churchill's figures prove nothing. As to the quotations from the German and Turkish officers the ordinary critic is in a better position. General Liman von Sanders is a better authority than Colonel Salaheddin, or Captain Serri or Major Endres, and this is how he speaks of the naval attack of March 18. "In spite of a heavy expenditure of ammunition, the success of the enemy fleet was slight . . . the 18th of March is and remains the day of glory for the Dardenelles forts and the upper command of the sea front (*Fünf Jähre Turkei*, page 75)." Could he possibly have used such language if there had been the slightest doubt in his mind that the naval attack was finally defeated by the land fortifications, and that its renewal would have led to a fresh and even more conclusive disasters?

It is, perhaps, in his narrative of the Dogger Bank action that the strength and weakness of Mr. Churchill's pleading are shown in their strongest relief. In language of extraordinary force and brilliance he describes the indications of a German sortie, the counter measures, the shock of the two opposing forces, and the hurried flight of the defeated Germans. The facts of the action are these. Thanks to our system of intelligence, Admiral Beatty fell in with Hipper's scouting groups in the early morning of January 24. Admiral Hipper, knowing that he was not supported, was compelled to turn for home, as for all he knew, he was confronted with very much larger forces than he could locate at the moment. Admiral Beatty then pursued him, and the two squadrons fought out an artillery duel of extraordinary interest. If we exclude the firing at close range, which destroyed the Blücher, our battle cruisers hit the Germans four times and no more; two of those four hits, being made at long range, did enormous damage, as the projectiles fell almost vertically and burst between the decks. The other two hits were comparatively harmless, though one of them started a local fire on the Derfflinger's boat deck. The German firing, on the other hand, was terribly accurate; for every hit of ours, they registered three or four; and, as we know, the Lion was driven out of the line, and Admiral Beatty made a manœuvring signal which broke off the action. This engagement had all the outward appearances of a brilliant British victory; but its inner significance was very different. It showed the German staff that their gunnery was better than ours; and that, thanks to their higher technical skill and the heavy armour protection of their ships, their battle-cruiser squadron could face ours with a good chance of being successful. In other words, the real lesson of the Dogger Bank was a dark and solemn warning, that, in many points, upon which we thought ourselves supreme, we were not up to the standard of our enemies. We did not take the warning, and the disasters of Jutland were the consequence of our neglect.

These awkward facts are perfectly well known to Mr. Churchill; as they are set out in the German staff history, which he has very carefully consulted. In spite of this, he has not mentioned them in his narrative, or made the faintest suggestion that the battle of the Dogger Bank was not the brilliant success we thought it. After admitting that Mr. Churchill was not writing history, and making full allowance for his wish to present things as they appeared at the time, his omission is very difficult to understand.

But no matter how cautiously Mr. Churchill's book will be read by historians of a future generation, nothing will deprive it of a high position in historical literature. When no memorials of our struggles and sufferings exist beyond those which have been engraved on stone or impressed on paper, students of history will place Mr. Churchill's volumes on their shelves alongside the memoirs of Sully, the "*testament politique*" of Richelieu, and the histories of Philippe de Commines and of Guicciardini; where they will be received with honour by a brilliant and distinguished company.

Recent Developments in Atomic Theory. By Leo Graetz. Translated by Guy Barr. London: Methuen and Co., Limited. [Price 9*s.* net.]

The extraordinary discoveries in physical science made during the past thirty years have naturally led to attempts at popularising the new concepts. In the case of the doctrine of relativity, it cannot be said that much success has been achieved. Our intuitions as regards the nature of space and time are too engrained, and are so firmly supported by our ordinary everyday experience that it is generally impossible for the average man even to comprehend the nature of the modifications suggested. Less difficulty attends the new ideas as to the nature of matter, since although the physicist tells us that all matter is built up of electricity, and all mass is electrical, yet in his model atom, the electrons are represented as whirling round a central sun, much as the planets do, and it is possible, therefore, to picture the organisation in terms of the familiar concepts of masses and accelerations. Hence it is proved fairly easy to convey to the non-specialist some knowledge as to the nature of the new discoveries.

The volume on "Recent Developments in Atomic Theory," translated from the German of Professor Leo Graetz by Mr. Guy Barr, is exceptionally well adapted to this end. There are very many people who are unable to afford the time to study original papers or to work through the mathematics involved, but who nevertheless are anxious to keep in touch with the development of physical science, and to gather at least a general idea of the methods by which it has proved possible to calculate the size of the atoms, their closeness of packing and the elementary ionic charge. Professor Graetz devotes his opening chapter, in the main, to the molecules and atoms of the chemist, who was concerned only with what may be called their external properties, and he gives an outline of the considerations which made it possible to estimate their size and free path. He then goes on to show that the spectroscope provided, at least an indication, that these atoms must have a structure.

It must be some fifty years since Maxwell indicated that our best hope of discovering something about this structure lay in studying the discharge of electricity through gases, and in his second chapter Professor Graetz describes the methods used, and the fertile observations made in this department. He would seem, however, to do somewhat less than justice to Sir William Crookes in this matter, since although he mentions that Crookes believed that the cathode rays were charged particles, he fails to record that Crookes was also firmly convinced that these particles were not ordinary matter. We now know that Crookes' insight had not failed him, and Professor Graetz describes clearly the general character of the methods by which it was finally proved that these particles had a mass only $\frac{1}{1800}$ that of the hydrogen atom.

Positive-ray analysis is also dealt with satisfactorily in the same chapter.

Radioactivity and atomic disintegration are next discussed, and in this section will be found reproductions of some of Mr. Wilson's remarkable photographs and α-ray tracks. The question of the size of the positive electricity associated with the atom is also dealt with here. At the outset it will be remembered it was assumed that the atoms were constituted by shells of electrons embedded in a comparatively large sphere of positive electricity. It was Rutherford who showed that this concept could not be reconciled with his experiments on the scattering of α-rays, and who proved that the positive nucleus must be very small in comparison with the dimensions of the atom. Thus, in the case of the hydrogen atom at any rate this nucleus is very much smaller than the electron. Professor Graetz states that if a hydrogen atom were magnified to the diameter of the earth the nucleus would be about as large as a cricket ball, whilst the electrons would be as big as a very large church. This simile illustrates very suggestively how very large is the "unoccupied" space within an atom, since even the uranium atom has only 46 electrons outside of its nucleus. An instructive chapter on X-ray spectra follows in which will be found a very readable description of the Laue's proof that the X-rays are really a form of light. Laue's method as modified and developed by the Braggs, has given us much information as to crystal structure. Moseley's discovery that the characteristic property of an element is its atomic number and not its atomic weight is also dealt with here.

The next chapter is devoted to a discussion of line spectra and of Bohr's most ingenious hypothesis which in spite of still outstanding difficulties has proved of extraordinary value in providing a picture of how radiation occurs. The final chapter gives an account of Rutherford's experiments on the disintegration of atoms by α-rays.

Throughout the whole volume the author's theme is developed in a consecutive and orderly fashion, and a good word must be said for the translator, who writes English and not the aggravating "translatese" which is so frequently met with in the case of writers who find it impossible to escape from the idiom of their original. The matter of Professor Graetz has, in fact, passed through Mr. Barr's brain and not merely through his pen.

BOOKS RECEIVED.

Aeronautical Research Committee. Reports and Memoranda. No. 854. *The Measurement of Aeroplane Speed with Special Reference to the Use of a Suspended Static Head.* By H. L. Stevens. [Price 9½*d.* post free.] No. 861. *Determination of Lift and Drag Coefficients during a Stall by Means of Accelerometers.* By F. W. Meredith. [Price 9½*d.* post free.] London: His Majesty's Stationary Office.

The Poulsen Arc Generator. By C. F. Elwell, B.A., M.I.E.E. London: Ernest Benn, Limited. [Price 18*s.* net.]

Imperial Institute. Monographs on Mineral Resources with Special Reference to the British Empire. Nickel Ores. By W. G. Rumbold. London: John Murray. [Price 5*s.* net.]

Mechanics of Machinery. Mechanism. By Robert C. H. Heck. First edition. London: McGraw-Hill Publishing Company, Limited. [Price 25*s.* net.]

Radio Telegraphy and Telephony. By E. W. Marchant, D.Sc., M.I.E.E. Liverpool: University Press of Liverpool, Limited. London: Hodder and Stoughton, Limited. [Price 6*s.* net.]

Das Segelflugzeug. By Dr. Ing. W. v. Langsdorf. Munich: J. F. Lehmanns. [Price 3*s.* 6*d.*]

Die Gleichstrommaschine. Vol. I. *Theorie, Konstruktion und Berechnung.* By Dipl.-Ing. Fr. Sailinger. Berlin and Leipzig: Walter de Gruyter and Co. [Price 1 gold mark.]

Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year 1922–23. London: His Majesty's Stationery Office. [Price 4*s.* 2*d.* post free.]

Aeronautical Research Committee. Reports and Memoranda No. 833. *The Design of Tapered Wings.* By W. S. Farren, M.A. London: His Majesty's Stationery Office, [Price 1*s.* 0½*d.* post free.]

Union of South Africa. Department of Mines and Industries. *Annual Reports of the Secretary for Mines and Industries and the Government Mining Engineer. December* 31, 1922. Pretoria: Government Printing and Stationery Office. [Price 10*s.* 6*d.*]

Electricity Supply Acts, 1882–1922. *Third Annual Report of the Electricity Commissioners, April* 1, 1922, *to March* 31, 1923. London: His Majesty's Stationery Office. [Price 2*s.* 6*d.* net.]

Wireless Facts and Figures. By A. V. Ballhatchet. London: Percival Marshall and Co. [Price 6*d.* net.]

LAUNCHING A NEW BOW FOR A SALVED STEAMSHIP.

It is sometimes the case that the salving of a complete vessel presents difficulties which are insurmountable even with the great resource of the skilled exponents of that exacting calling. In some cases of that character the entire vessel is not abandoned, for the sacrifice could be limited to a part of the ship and the rest saved for reconstruction. The aim in an endeavour of this type has usually been to save the after-end with its valuable propulsion machinery and abandon the fore part, which may extend to about one-third of the length of the ship. As an example of this character mention may be made of the case of the ss. Milwaukee, owned originally by the Elder Dempster Line, but later in the possession of the Canadian Pacific Company. In 1899 this vessel, which had a length of 500 ft., was wrecked on the Aberdeen coast and in the salvage operations had to be cut in two. Dynamite cartridges were used, and after the separation the bow was abandoned but the after portion was taken to Wallsend-on-Tyne, stern first, by tugs, but assisted by her own engines. Messrs. Swan, Hunter and Wigham Richardson built a new bow which they successfully launched from their yard. The two portions were then brought into proper relationship in the dry dock and joined up, thus affecting a most successful piece of repair work.

Another case where a similar procedure was adopted was that of the White Star liner Suevic,

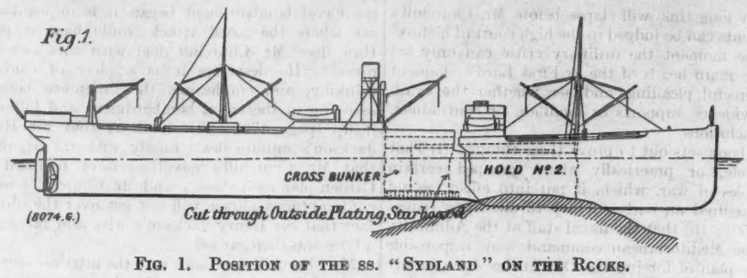


Fig. 1. Position of the ss. "Sydland" on the Rocks.

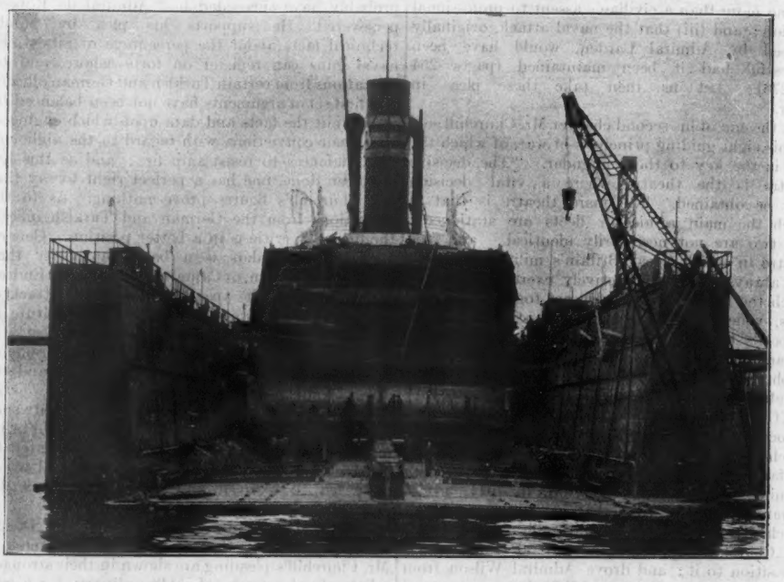


Fig. 2. After End of the Salved ss. "Sydland" in Floating Dock for Measurement.

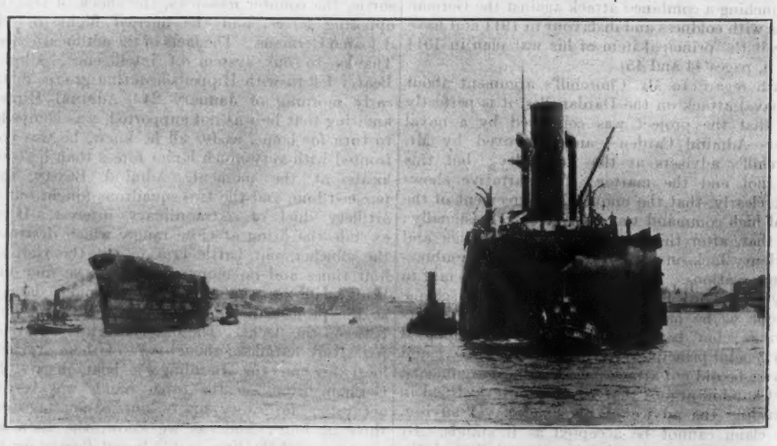
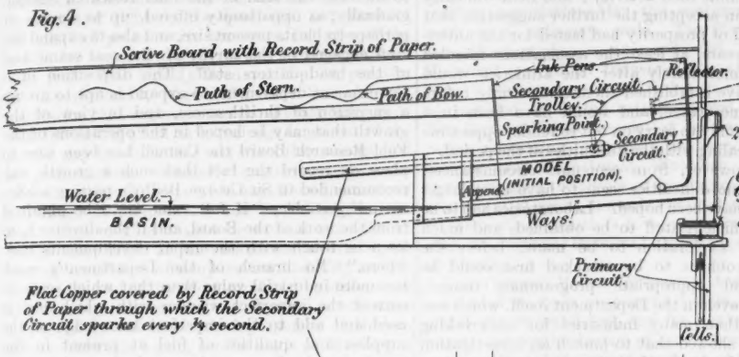
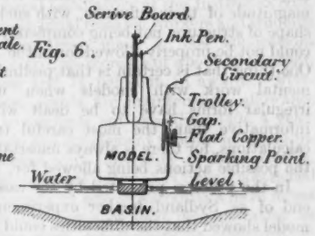


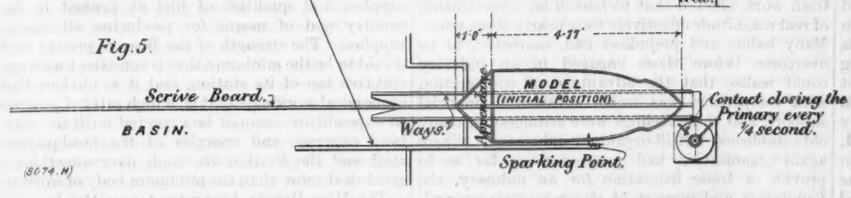
Fig. 3. After End and New Bow of the ss. "Sydland" being Towed to Dry Dock.

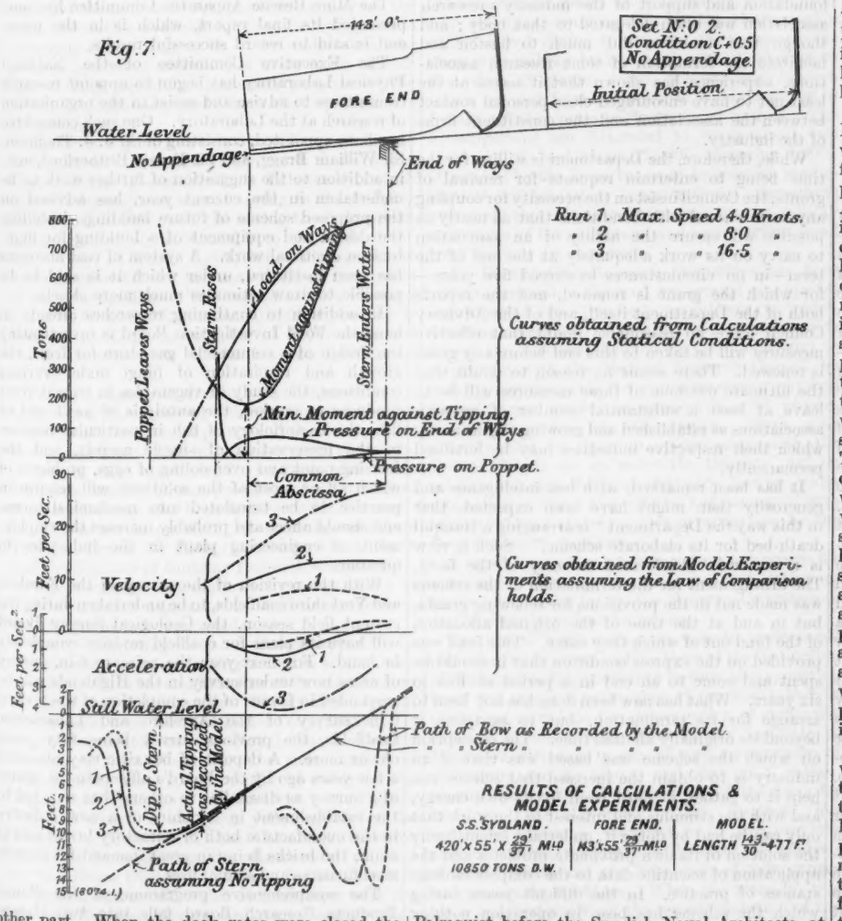
which went ashore off the Lizard on March 17, 1907. The after part was severed from the bow in the salvage work and was towed to Southampton for docking. A new bow was constructed by Messrs. Harland and Wolff at Belfast and towed round to Southampton. After unloading and trimming it was taken into the Trafalgar dock for association with the other part. When the dock gates were closed the water was partly pumped out, the alignments and adjustments were then made, and heavy timber guides were used to ensure that the correct position was taken up by the bow. When drawn into place the two parts were held together by stretchers while two frames were built in and the work on the bulkheads, decks, &c., was done. Again a successful achievement was recorded and the vessel was put back into useful service.

Of a third example of similar character, but one for which a fair amount of preliminary test work was undertaken, we can now give particulars, thanks to a paper on "The Launching of the New Fore End for ss. Sydland," which was read by Mr. A. Palmquist before the Swedish Naval Architects, at Gothenburg, in August last. Illustrations relating to this repair work appear on this page and on pages 580 and 594. During a fog on December 20, 1921, the vessel, one of the fleet of the Tirfing Steamship Company of Gothenburg, ran upon a submerged rock outside the harbour when on her first return visit to her home port. The position which the vessel occupied on the rocks is indicated in Fig. 1. As it was quite impossible to salve the whole ship, Captain C. Malmborg, of the Gothenburg Towage and Salvage Company suggested the method already referred to in connection with the cases of the ss. Milwaukee and ss. Suevic, of sacrificing the fore end in an effort to save the larger stern portion and the machinery. The ship was 420 ft. in length, 55 ft. breadth and 37 ft. depth from the shelter deck. It was, at the time of the accident, fully laden, the deadweight tonnage being 10,850. Cutting by means of gas and the use of dynamite were resorted to for the division of the ship at the place where the plating had already been cracked on the starboard side. The last ties were broken by the heavy seas prevailing during a southernly gale on January 4, 1922, and the salvage steamers were able to pull the after part clear of the rocks. It remained floating as the strong cross-bunker bulkhead was intact and temporary ones had been fitted in the 'tween decks. It was then able to proceed under its own steam into Gothenburg Harbour. Meantime the fore end had slid off the rocks into the water and actually lies at a depth of about 11 fathoms.









RESULTS OF CALCULATIONS & MODEL EXPERIMENTS.

S.S. SYDLAND.	FORE END.	MODEL.
420'x55'x 29/37 M.D	143'x55' 29/37 M.D	LENGTH 143'/30=4·77 F.
10850 TONS D.W.		

Of restoration was entrusted to the Eriksberg Mek. Verkstads A.-B. of Gothenburg, who found that the docking of the salved portion for the building on of a new fore end involved a prolonged occupation of their largest floating dock. As this would limit the activity of the firm unduly, it was decided to build a new bow of 143 ft. length o n one of the building berths of the yard, and after launching it connect the portions together in dry dock. Some use of the floating dock was, of course, necessary, for measurements were required for use in the construction of the forward part, and the salved portion is shown in the floating dock for this purpose in Fig. 2. This method of dealing with the rebuilding of the ship not only gave freedom to the repairers in the use of their floating docks, but was in addition economical. There were, however, some difficulties which demanded consideration. They were those of launching and the adjustment of the two portions in the dry dock. The structure was different in so many ways from an ordinary vessel that it was thought advisable to conduct a series of tests beforehand with a model. Calculations had shown that it was impossible to launch the structure bow first because of the excessive tipping actions that would operate. Again, if the usual arrangement of concentrating as much weight as possible at the forward part to reduce the tipping actions was resorted to, a considerable dipping action was to be anticipated as the vessel left the ways. As this might put the structure in an unstable position, tests with a scale model were thought to be imperative.

A complete model of the vessel, ways and basin, was made to a scale of one-thirtieth. Drawings of the arrangements used are given in Figs. 4 to 6, the results obtained are shown in the graphs in Fig. 7, while the illustrations, Figs. 8 and 9, on page 594, further indicate the construction. The model was made of thin wood, and being lighter than the correct relative weight could be adjusted for the position of the centre of gravity and for the moment of inertia. As is indicated in Figs. 4 to 6, arrangements were made to record the variations in height of the two ends during launching, and also to show the movements in the fore and aft vertical plane by means of an optical lever. The launching speed could be regulated to any desired value and its magnitude determined. Surprising results were found, in many cases indicating effects

which were quite the opposite of what was expected from the calculations. As an example of this it may be stated that the model was found to tip when the calculations showed the existence of a large moment against tipping. Again the higher the speed of launching was made the greater were the tipping effects on the model. There are many actions which might cause the difference in these results and the magnitude of their influence, with such an unusual shape of structure, not being completely understood, could not be properly allowed for in the calculations. One thing that is certain is that preliminary experimental work with models when unusual and irregular forms have to be dealt with, is more informative than the most careful treatment by calculations, for there is always uncertainty as to all the possible actions being allowed for.

In the problem presented by the case of the fore end of ss. Sydland further experiments with the model showed that the difficulties could be overcome by building a temporary wedge wall of timber at the after end and keeping the launching weight down to a minimum. Tests showed no tipping actions with the model thus changed, even when the test speeds were equivalent to between 10 and 12 knots. The actual launching was performed in the way indicated as advisable by the tests, and was completely successful. The shelter deck plating and the shell plating of the 'tween decks was not fitted before launching, as this reduction had been allowed for in keeping down the centre of gravity in the model experiments. Fig. 10, on page 594, shows the building up of the frame for the wooden nose for launching purposes, and Fig. 11 shows the bow just after taking the water. The anticipated difficulties in docking the two portions, obtaining correct alignment and connecting them together were not experienced and the vessel thus rebuilt, is again afloat.

THE SCIENTIFIC AND INDUSTRIAL RESEARCH DEPARTMENT, 1922-3.

(*Continued from page 552.*)

THE report of the Advisory Council gives interesting details of the circumstances that have determined the decisions of the Department. This is seen notably in the references to the progress of Research Associations. From the outset the purpose of Parliament and the Department was so to stimulate industries that the majority of their constituent firms would form co-operative organisations for research, which ultimately would enable it to be carried out permanently on an adequate scale without the help of the State. It was with this object that grants by the Department in aid of research associations were limited to a period of five years, and it may well be that under more fortunate circumstances the period would have been sufficient for at least most of the industries. For the institution of an association with the benefit of a grant the Department required half the estimated minimum cost of operations over the five years to be assured by a minimum subscription income, and up to this minimum and to a second higher limit the grant in general was made on a *l.* for *l.* basis. Beyond this second limit further grant was to be made, if funds were available, but only on a progressively diminishing scale. After the associations had passed the higher limit they would themselves have thus been providing an increasing proportion of their own funds, and by the end of the five years would have had enough subscription income to carry on without external help.

As a fact, however, only 7 associations out of 22 in actual operation have exceeded the upper limit, and the majority have done little more than reach the minimum. This failure to realise expectations that admittedly had been formed at the inception of the scheme is attributed in a large measure to the course of industrial events. The first year of the scheme's operation coincided with the last year of the war, and only four associations were formed before the armistice was signed. The next period may be taken to coincide with that of the commercial boom following on the armistice, which was expected generally to last five years, but in fact lasted barely two. During this period 17 associations came into operation; and during the next period, from the end of 1920 to the present date, which has been one of the gravest industrial depression, only one association has been formed. These figures seem to confirm cogently the Council's opinion that the unfortunate course of trade tended not only to impede the formation of associations, but also to limit their activity; and little difficulty will be felt in accepting the further suggestion that if the period of prosperity had lasted for the anticipated five years, at least the associations founded before, or immediately after, the armistice would probably have established themselves firmly before the bad times came, and would have been in a position not only to carry on but to render opportune service in dealing with the difficulties of the period.

Apart, however, from economic circumstances, some intrinsic difficulties seem to have been larger than might have been hoped. Laboratories had to be equipped, efficient staff to be obtained, and much preliminary exploration to be made, before the essential problems to be attacked first could be realised and appropriate programmes framed. Experience even in the Department itself, which was better off than many industries for undertaking fresh work, showed that to launch an investigation of real magnitude effectively took nearly three years. Many habits and prejudices had, moreover, to be overcome before those engaged in an industry could realise that the advantage of co-operation with competitors was worth substantial financial support, and these feelings were strongest in many old-established but ill-organised industries. Where again organisation had progressed so far as to provide a trade federation for an industry, the foundation and support of the industry's research association was often delegated to that body; and though this doubtless did much to hasten and facilitate the formation of some research associations, experience has shown that it seems at the least not to have encouraged close personal contact between the association and the constituent firms of the industry.

While, therefore, the Department is willing for the time being to entertain requests for renewal of grants, the Council insist on the necessity for coupling any such renewal with conditions that as nearly as possible will ensure the ability of an association to carry on its work adequately at the end of the term—in no circumstances to exceed five years—for which the grant is renewed, and the reports both of the Department itself, and of the Advisory Council leave no reasonable doubt that effective measures will be taken to this end before any grant is renewed. There seems no reason to doubt that the ultimate outcome of these measures will be to leave at least a substantial number of research associations as established and growing organisms by which their respective industries may be fertilised permanently.

It has been remarked, with less intelligence and generosity than might have been expected, that in this way the Department "is arranging a tranquil death-bed for its elaborate scheme." Such a view is a curiously ill-informed travesty of the facts. The arrangement for the termination of the scheme was made not in the provisions for renewing grants, but in and at the time of the original allocation of the fund out of which they came. This fund was provided on the express condition that it should be spent and come to an end in a period of five to six years. What has now been done has not been to arrange for its termination, but to postpone it beyond its originally allotted time. The conception on which the scheme was based was that if an industry is to obtain the increase that science can help it to gather, it must itself by its own energy, and with the stimulus and interest in the work that only can be had by doing it, undertake scientifically the solution of its own proximate problems and the application of scientific data to the complex circumstances of practice. In the difficult years during which the scheme has been in operation nothing has happened which throws doubt on the truth of this proposition; and the Department is to be congratulated on the judicious firmness with which, while adjusting the details of its action to fit the unexpected course of commercial history, it has adhered to the wise and stimulating conception of its original scheme. Seldom, indeed, is a Government department found so sedulous not in magnifying its office, but in insisting that it shall be taken over by its *administrés* themselves.

In connection with the development of the Fuel Research Board announced by the Department the Council's report discloses the circumstance that in retiring Sir George Beilby laid stress on the need to increase the staff of the Fuel Research Station gradually, as opportunity offered, up to double or perhaps treble its present size, and also to expand the staff engaged in the survey of the coal seams and of the headquarters staff. The disposition of a Government department to expand is apt to arouse a suspicion of thriftlessness, and in view of the growth that may be hoped in the operations of the Fuel Research Board the Council has been wise to place on record the fact that such a growth was recommended in Sir George Beilby's parting advice as indispensable, "if full value is to be obtained from the work of the Board, and if the director is to keep in touch with the rapid developments elsewhere." No branch of the Department's work has more industrial value than that which seeks to correct the imperfect wisdom with which fuel is used and add to the imperfect knowledge of the supplies and qualities of fuel at present in the country and of means for producing alternative supplies. The strength of the Board's present staff is said to be the minimum that is consistent with any effective use of its station, and it is obvious that economical working—that is, a high ratio of progress to expenditure—cannot be expected until the overhead expenses and energies of the headquarters staff and the Station are sunk over something a good deal more than the minimum body of workers.

The Mine Rescue Apparatus Committee has now presented its final report, which is in the press, and is said to record successful results.

The Executive Committee of the National Physical Laboratory has begun to appoint research committees to advise and assist in the organisation of research at the Laboratory. One such committee has been appointed, consisting of Sir J. J. Thomson, Sir William Bragg, and Sir Ernest Rutherford, and, in addition to the suggestion of further work to be undertaken in the current year, has advised on the proposed scheme of future buildings, including the design and equipment of a building for high-tension electrical work. A system of cost accounts has been instituted, under which it is said to be possible to draw estimates much more closely.

In addition to continuing researches already in hand the Food Investigation Board is investigating the design of a commercial gas store for fruit, the growth and respiration of fungi under various conditions, the study of vegetables in transit from producer to market, the autolysis of meat and of fish, the bacteriology of fish in particular relation to the preservation of simple asepsis, and the freezing-point and overcooling of eggs, problems of which all or most of the solutions will require in practice to be translated into mechanical terms, and should affect and probably increase the employment of engineering plant in the industries in question.

With the revision of the survey of the Fifeshire and Yorkshire coalfields, to be undertaken during the current field season, the Geological Survey Board will have its plans for coalfield revision completely in hand. For next year the primary 6-in. survey of areas now under survey in the Highlands will be suspended in favour of the completion of the revised 6-in. survey of the Ayrshire and Lanarkshire Coalfields, the previous survey being fifty years old or more. A deposit of bauxitic clay observed a few years ago by the Board's officers in the course of a survey as dissimilar to others* has now led to the establishment in Ayrshire of a new industry in the manufacture both of refractory bricks and of alum, the bricks being in great demand for electric steel furnaces and similar uses.

The comprehensive programme of the Forest Products Research Board falls into two classes. Its main attention is given to fundamental problems, divided among its committees on extractives, seasoning, timber-mechanics, and identification and structure. The solution of these can evidently not

* Memoir of the Geological Survey on Ayrshire Bauxitic clay, by G. V. Wilson, B.Sc., 1922. Ordnance Survey Office, Southampton, or any Agent for sale of Ordnance Survey Maps. 1*s.* 6*d.* net.

be rapid, but no doubt can be felt that the Board is wise to persist in the endeavour to obtain a scientific basis for the treatment of timber in lieu of the collection of empirical data on which it mainly rests at present. The Food Research Board has been and is faced with a very similar position. It has chosen to make fundamental studies of animal and plant physiology and allied subjects, the results of which would throw light on the questions, not alone of the effect of preservative processes, but also of the reason for preservative effects and their mechanism. This policy has already been justified in practice (*cf.* ENGINEERING, page 180), and the cold and ventilation that engineers can provide are being used with increasing effect as knowledge is gained of the precise way in which they act when they are applied as preservatives. Similarly engineers can make kilns for seasoning to provide any desired variations and range of temperature and humidity; but the best design of kilns cannot be worked out without better knowledge of the reactions of timber to varying conditions of temperature, humidity and air circulation, and of the effect produced by differences of treatment in seasoning on chemical constitution and physical and mechanical properties of timber. Mechanical tests, again, can be made of varieties of timber, but while such tests remain empirical they will call for a constant succession of further tests, and will yield far less satisfaction than when the effect of variations of structure on strength has been scientifically worked out. Those who use timber will thus await with patience as well as interest the outcome of the fundamental investigations by which it is hoped to obtain these data. In the meantime the Board recognises the need in which practical men find themselves to act on whatever may be the best information available for the time being, and is arranging for testing work to be undertaken and perhaps seasoning experiments to be made in such way as may assist the immediate purposes of the Forest Commissioners and others who require results for present use.

The Council quotes in this connection an estimate in regard to the results of the work done by the United States Forest Products Laboratory, which puts the consequent annual saving in the building trades at 800,000*l.*, and the saving to all American industries, directly attributable to the work of the Laboratory, at about 6,000,000*l.*, which would be much increased if full use were made of the results of its investigations. The expenditure on its work seems to be something under 40,000*l.* a year, while that of the Department's Forest Products Board for the current year will lie between 5,000*l.* and 10,000*l.*

The programme of the Building Research Board includes further study of different kinds of cement and cement concretes, of paints and varnishes, of the economical use of fuel in brick-burning, of the use of certain new materials, by-products and waste materials, and of certain problems of construction. A committee has also been formed under the chairmanship of Sir Aston Webb, of which among others Professor Desch, Sir Herbert Jackson, Dr. A. Scott and the Director of Building Research are members, to report on the best methods by which decay in building stones, especially in ancient structures, may be prevented or arrested.

The Co-ordinating Research Boards appear to be of increasing use in combining as well as economising the efforts of the several branches of the Government service and of the industries. Bacteriological work, for instance, done for the Fabrics Co-ordinating Research Committee at the Royal Naval Cordite Factory, Holton Heath, on the deterioration of fishing nets, has yielded results of value to the Ministry of Agriculture and Fisheries; the Physics Research Board is studying yellow glass for the Ministry of Transport; the Chemistry Research Board is investigating the disinfection of wool for the Home Office and of ships for the Ministry of Health, and as the result of conference with the Medical Research Council has under consideration a co-operative inquiry to gather up and extend a good deal of scattered work now being done on disinfection in general. The Admiralty has offered the Radio Research Board facilities for study in the Indian Ocean, and a programme of research work already in hand for the Board was adopted without amendment at the International Conference on Radio-Telegraphy as the conference programme for international research. On Sir William Bragg's appointment as Fullerian Professor of Chemistry at the Royal Institution and director of the Davy-Faraday Research Laboratory the Department arranged for the research assistants provided for him under its grant to be transferred from University College to the Royal Institution, pending negotiations for the continuance of his work on an adequate scale. The Royal Aircraft Establishment has co-operated with the British Electrical and Allied Industries Research Associations to produce results of value in investigations on moulded insulating materials, and the British Non-Ferrous Metals Association has had an investigation on casting brass strip ingots carried out at the Research Department, Woolwich, in addition to receiving, on the advice of the Engineering Board, a substantial grant towards the cost of researches on die-castings, which is to be carried out at Woolwich, the National Physical Laboratory, and Sheffield University.

The Current Meters Committee has practically completed its tests on current meters, a report on which will be published, and for further work now awaits the establishment of an authority to carry out a survey of the water resources of the country.

The work on cleaning and restoring museum exhibits carried out by Dr. A. Scott and his scientific staff at the British Museum has led to so much call for assistance that arrangements have been made to train museum workmen in methods of restoration.

On representations by the British Engineering Standards Association, a sub-committee of which is undertaking the preparation of a British standard specification for girder bridges, the Department has now set up a committee under the chairmanship of Sir Alfred Ewing to conduct researches on the stresses in railway bridges, with special reference to the effect of moving loads, the existing data on which are not found sufficiently comprehensive to form a reliable guide to designers of bridges. The investigations are estimated to cover about two years and to cost about 17,000*l.*, including 2,000*l.* stipulated by the Department to be spent on mathematical and laboratory investigations. Something over half the cost is to be borne by the railway companies of Great Britain, and some further small contributions are expected.

An Illumination Research Committee has been set up to examine the need for general and special investigation into illumination problems, to undertake the supervision of such investigations as on its report the Advisory Council may approve, and to co-operate with the Medical Research Council by making arrangements for and supervising physical investigations needed in connection with physiological researches on illumination. Work may possibly also be done in co-operation with the Dental Boards set up under the Dentists' Act on subjects of metallurgical dentistry having wider interests than those of dentistry, and connected with other problems already under investigation by the Department or elsewhere.

A small committee has been set up to arrange for a scientific investigation into the root action of forest trees, asked for by the Forestry Commission, and likely to have fruitful results.

The grants made during the year to professional and other institutions include those of the Institution of Mechanical Engineers into ferrous alloys, cutting tools and steam nozzles, that of the Institution of Civil Engineers into the deterioration of structures exposed to sea action, those of the Institute of Metals on corrosion in general and on corrosion of aluminium and its alloys, and that of the Manchester Association of Engineers on lathe tools for cast-iron. The Liverpool Tidal Institute has continued the work described in its two previous annual reports, dealing mostly with the analysis of observations and the behaviour of tide gauges and predicting machines. When the grant for this work was first made on the recommendation of the British Association and the Admiralty in 1920, the Council expressed the belief that the results would be of such value as to secure the necessary support from shipping firms and others interested. Presumably being satisfied that such results have now been obtained, the Council expresses the view that the shipping industry should make the necessary provision for continuing the work, and that further grants for the purpose should not be made from public funds. Arrangements have now been made for the regular issue of the *Journal of Scientific Instruments*, of which a specimen number was prepared and circulated in 1921–22, with the help of a grant from the Department. The Institute of Physics will provide for publication, general finance, and management, and the journal will be edited at the National Physical Laboratory at the Institute's cost.

Grants to individual research workers and students in training have been made on 304 applications out of 668 received, an increase of about 20 per cent. in applications and 7½ per cent. in awards. Five-sixths of these grants are maintenance allowance to students to amounts not exceeding 140*l.* a year. These are made as a supplement to what may reasonably be expected from university or local sources, and are never exceeded unless the Council is satisfied that the university or college authorities have found it impossible by means of paid demonstrating or other teaching work, scholarships or otherwise, to make good the deficiency in the student's resources, should the grant with any private means he may have be insufficient to maintain him. The limitation is made because the Council regards a quickening of the sense of local responsibility as vital to the progress and well-being of research. The Council now also throws on the university or college the responsibility of certifying that full advantage of all other sources of assistance has been taken before arriving at the recommended minimum allowance sufficient to maintain the student, though the individual professor remains solely responsible, as heretofore, for the selection of the candidate on the ground of his promise.

An important caution is given in regard to the choice by students of the sciences they intend to follow, a choice that has practically to be made while they are still undergraduates. Of the grants sought and awarded this year three-fifths were for chemistry, over four times as many as for either physics or biology, and over six times as many as for engineering. A large number of chemists are known at present to be unemployed, and so large a number of students have recently graduated in chemistry that "many of them cannot hope to obtain satisfactory scientific employment, including teaching employment, in the near future." It is therefore in the Council's judgment imperative that university and college authorities should consider this situation most carefully, and in the interests of the students as well as of the nation take account of the prospects of employment which different branches of scientific study offer. The Council will itself increasingly restrict its grants to post-graduate students in chemistry, and as a hint mentions the fact that it would be glad to be able to recommend allowances to more students to be trained in biology and physics.

The present premises of the National Physical Laboratory, at Teddington, which began with the conversion of a part of Bushey House, and have grown up with the inconvenience inevitable to building without a pre-arranged plan, are insufficient for its purposes, and in some ways ill-adapted to them, and no funds are available out of which adequate accommodation for physical work and other research can be erected. An adjoining estate was, however, bought in 1920, intended ultimately as the site of Government research establishments, and during the present year plans have been made and approved for laying out this estate with roads out of funds allocated to the relief of unemployment, in such a way as to provide suitable square sites for buildings to be erected when the money is available for them. At present the only substantial use that can be made of the site out of available funds is the erection of a building for testing high-tension electrical apparatus and its equipment for pressures ultimately reaching a million volts, near the building in which the illumination of buildings is to be investigated. Several other buildings are, however, felt to be wanted urgently. The first, having regard to the Laboratory's primary object, is intended to be a physics building. A high-speed tank for extending the conspicuously successful work of the National Froude tank is badly needed for investigations that should be of considerable and direct benefit to the shipping industry, but in

the absence of donations (such, though the report does not mention it, as that of Sir Alfred Yarrow, by means of which the Froude tank was provided), the Council can see no likelihood of the necessary funds being available.

A building and an institution of a more general scope that appears also to be badly wanted is what would be substantially a National Chemical Laboratory. It is certainly common knowledge that at present the Government Chemist cannot make any systematic investigation of questions having industrial or even analytical interest except as they arise in the course of routine Government work. There are, however, many questions of wide importance that seem particularly to require the attention of a central laboratory, not wedded to any particular purpose or industry. The infinite and constantly increasing number of analytical methods cause an inconvenience and loss of certainty when comparing the results of different workers that could be largely or wholly avoided if methods were standardised in such a laboratory. There are, again, an extremely large number of industrial questions—bio-chemical work on, for instance, the production of alcohol, dyes, disinfectants are only a few examples—that have an importance far beyond the scope of any individual industry, and by reason of the necessity for investigations in quasi-industrial conditions cannot be carried out in university laboratories. Whether Nebuchadnezzar in his grazing days learned how to convert the cellulose in grass into fermentable sugars, every cow does it without difficulty, and the laboratory that can do as much with the automatic ease of the cow will have gone very far to lay the bogey of dear fuel, and to cheapen much else in the chemical industries. It is indeed difficult to estimate the gain that might reasonably accrue from such investigations, if they were carried out in suitable conditions.

The last matter with which the Council's report deals is the future of the Imperial Institute, in view of the withdrawal of overseas contributions and the Institute's consequent financial difficulties. Appealed to by the Colonial Office for its opinion, the Department has recorded its view that "a clearing house of scientific and technical information and of the industrial and commercial information related thereto is a necessary part of any effective policy of imperial, and especially of inter-imperial trade." The opinion is doubtless unexceptionable, but it does not seem to show with any clearness how and by whom the clearing-house is to be provided. More light may be thown on the Department's views when its final report on the subject is prepared. In the meantime the question seems to be eminently one for the consideration of the Imperial Economic Conference now sitting.

(To be continued.)

THE MOTOR EXHIBITION AT OLYMPIA.

(Continued from page 568.)

ONE of the outstanding designs of light cars is the 7-h.p. Austin. This machine has now established a very good reputation on the road and has gained a number of awards in competitive tests. Amongst these the most important were the victory in the Italian Grand Prix and the records established at Brooklands by Mr. Gordon England, one of which was the travelling of 73¼ miles in an hour, and another the maintenance of a speed of 79·6 miles per hour over a distance of 5 miles. This model was introduced by the Austin Motor Company, Limited, of Longbridge, near Birmingham, as a vehicle which would appeal to the former users of motor cycles and side car combinations, and judging from its performance and the moderate price it is produced at, the anticipations may be expected to be realised.

It has a four-cylinder water-cooled engine, three-speed gear-box, a bevel drive through a differential gear, and brakes are fitted on all four wheels. The details of the chassis construction, the arrangements of the front and back axles and a new mechanical starting gear are shown on Plate XXXIII. The frame is built up from two pressings of channel section with side lips and a connecting pressing at the front. Two pieces of channel section are used as cross bracings to obtain the requisite stiffness. From the free ends of the side members quarter-elliptic springs extend to the rear axle, while the third point of suspension is obtained from the middle of a semi-elliptic spring connecting the ends of the front axle. The front axle is a forging of H-section. On its ends the swivel pins for the hubs are fitted. The steering connection is connected to one side of the casting surrounding the swivel pin and is seen in Fig. 5, above the spring. Motion for this is obtained from the steering wheel by a worm on the shaft which engages with a sector on which the steering arm is mounted. Brakes of the internal expanding type are provided in the brake drum connected to the hub. They consist of two semi-circular shoes with fabric linings. They are pinned together at the one side and rest against a cam at the other, and this can be turned to force the brakes into action by motion obtained from a hand lever.

The engine is built up as one unit with the gear box and the mechanical starter. There are four cylinders of 2·2 in. bore and 3 in. stroke, which gives an R.A.C. rating of 7·8 h.p. The cylinders are cast *en bloc*, and a detachable head affords facilities for decarbonising or getting at the valves for regrinding. The drive for the camshaft and for the magneto is by means of gears. From the engine the power is transmitted through a single plate clutch to a gear box, with provision for three speeds ahead and one reverse. From the gear box a shaft extends which has metal universal joints at its two ends and is coupled to the final transmission shaft. The bevel pinion at the end of this shaft engages with the bevel wheel of the differential gear. On this are mounted a series of six pinions, Fig. 8, by means of which the drive is communicated to the two driving shafts of the back axle. On the coned ends of each of these the hubs of the rear wheels are held by semicircular keys, and the end is screwed for the nuts. The brakes on the rear wheels are similar to those used on the front wheels, but are operated by a lever system obtaining its motion from a pedal. The mechanical starter is shown in Fig. 4. It consists of a spring controlled cable drum around which is wound a flexible cable. In the wound position this drum is not associated with any part of the running engine, but it has fitted to it a toothed wheel, which is seen within the housing at the left of the illustration. When the projecting shaft on which the drum is mounted is pushed in by the foot the teeth of the wheel engage with those of a ring bolted to the flywheel. With the gear pressed into engagement any pull on the flexible cable turns the drum and the flywheel and gives the necessary motion for starting. The moment the operation is completed the drum is brought back into the off position by means of the springs.

The firm of Ruston and Hornsby, Limited, of Lincoln, have established an enviable reputation for soundness of construction in the many types of engineering plant they manufacture, and have endeavoured to win for their motor cars the same degree of esteem. Certainly the qualities of sound construction such as we know and appreciate in the products of British works are manifest in the designs which they have standardised. They concentrate on two models with 16 h.p. and 20-h.p. engines, and these with different types of bodies are submitted for inspection in the Exhibition. The chassis, engine and other components of the 20 h.p. car are illustrated in Figs. 9 to 21 on Plate XXXIV. The engine, clutch and gear box are made up into a single unit, and the box of the steering system is mounted on one of the tubular castings which are used for its support on the frame. The greater part of the mechanical gear of the car is thus assembled in one complete unit, and its arrangement can be seen in the views of the two sides, Figs. 20 and 21.

The cylinders are of the monobloc type, but spaced apart in pairs to give room for the provision for the centre bearing of the crankshaft, which thus has three-bearing support. The crankshaft is made very stiff, to reduce those periodic vibrations which frequently spoil the performance of a four-cylinder engine. The cams are solid with the camshaft and are case-hardened and ground to form. The shaft revolves in three bearings, and thrust is taken in either direction by large steel flanges which run against the cast-iron bearing forces. Motion is taken by belt from the end of the camshaft for the driving of the fan. The lubrication system is particularly good. Oil is forced under pressure through pipes that are cast as part of the crankcase, and from them conveyed to the crankshaft bearings and through channels in the crankshaft to the connecting rod big ends. It is also conveyed to the camshaft bearings in a similar way to that used for the crankshaft, to the timing wheels and, in fact, to every part of the engine except the pistons and gudgeon pin bearings, which are lubricated by splash from the oil sump. On the piston, scraper-rings are provided at the lower ends, and draining holes are drilled beneath them. The pump which provides the lubrication is a novelty in the design, and can be entirely removed from the engine at any time. It is shown in the cross-sectional view of the engine, Fig. 13. The pump is of the gear type. The oil is drawn through a filter in the sump, then passed up the foot pipe into the space between the meshing teeth of the revolving wheels, then passes through a nozzle into a pressure filter chamber which is provided with two successively finer gauzes made in the form of cylindrical tubes. From here the oil passes directly to the pipe system. A pressure relief valve is situated at the top of the equipment and near the outlet. As this may be observed in action when the filler cover and anti-splash device are removed, it is possible to detect immediately if there is any trouble due to dirt getting below the ball of the relief valve. This is only necessary, of course, when the indication of the oil pressure given on the gauge on the dashboard shows insufficient pressure.

The clutch is of the direct-cone type, and there are four springs, the reactions of which are taken through special steel pins to a plate between the clutch and flywheel, where the thrust is taken by a ball race. The illustrations, Figs. 14 to 18, show how the gears are mounted so that they can be put in mesh with the wheels on the two long shafts to obtain the required combinations for the three speeds and reverse. The lever, being on the engine-gear box unit, is centrally placed and has the appearance of a joy-stick, but is, in reality, the control for a gate-change system with a concealed type of gate. The propeller shaft is a comparatively light tube with the ends brazed on to it. At the front, Hardy flexible discs are used and are protected from water and mud by a cover which completely encloses them. At the rear end there is a sliding pot-type joint made entirely out of hardened and ground steel parts. With this the concertina-type of grease retainer fitted has proved very effective. The rear axle is of the type known as semi-floating. This means that the wheel is secured by means of its hub rigidly to the axle-driving shaft. The hub is mounted upon a ball bearing, the inner race of which is supported by the axle tube; thus in a semi-floating axle the axle shaft is subject to torsion, and in addition receives the strain from the road wheels, in the form of a bending movement, when side pressure is exerted upon the tyre of the wheel, as is the case when the rear wheel comes into contact with the pavement kerb when being brought to rest. A spiral bevel drive is used, and as the highest loads experienced are those received by the pinion in axial thrust, a very large single thrust bearing is provided which acts in both directions. Ball bearings are used throughout, except that the journal load is taken by two bearings of the short roller type. The front axle is a drop stamping of H-section, and the king pins which are driven into the front axle have their bearings in the stub axle, and these are provided with phosphor bronze bushes. A steering gear of the worm and complete wheel type is fitted, and the details of it are clearly shown in Figs. 9 to 11. Mounted on the lower end of the steering pillar are the cam controls, the introduction of which has removed the necessity for many of the bell cranks, ball joints, rods and levers which are common in some types of control systems.

The exhibits of Vauxhall Motors, Limited, of Luton, comprise three models in which there are a number of new features. The 23-60 h.p. car may be considered as the weight carrier, the 14-h.p. model is a lighter model, while the 30-98-h.p.

EXHIBITS AT THE MOTOR SHOW AT OLYMPIA.

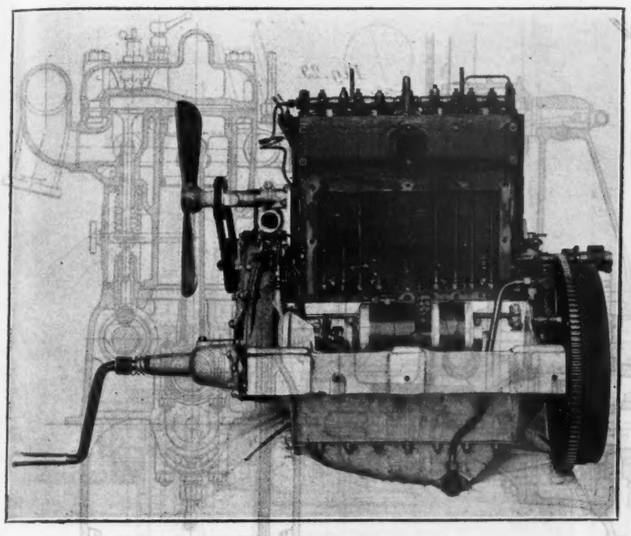


Fig. 25.

Fig. 25. 14-H.P. Engine; The Standard Motor Company, Limited, Coventry.

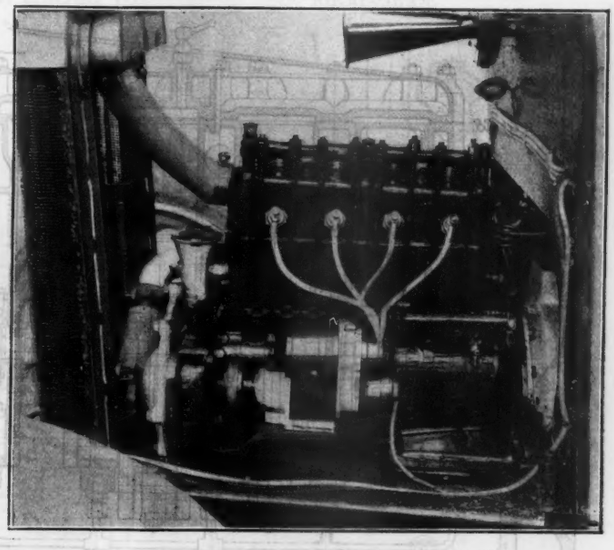


Fig. 26.

Fig. 26. 11-H.P. Engine; The Standard Motor Company, Limited, Coventry.

machine represents the provision for the demand for an extremely fast touring car. The 23-60-h.p. Vauxhall has fitted to it the Lanchester harmonic balancer, which was devised by Mr. F. W. Lanchester, to solve the problem of the unbalanced secondary forces which give rise to vibration in a four-cylinder engined car. This is illustrated in Fig. 22, on Plate XXXV, above the sections of the engine on which it is used. The device is driven by a large helical gear wheel mounted on a web on the crankshaft. This wheel engages with a drum with a gear cut upon it, and this in turn gears with a similar one at its side. These drums are mounted on a bracket fixed to the crank-case; they are fed with lubrication oil from the general system, and are surrounded by an oil trough. The drums are weighted in one half. The amount of the addition is determined to suit the characteristics of the turning moment diagram. As the secondary forces which these revolving weighted systems are to balance occur with twice the frequency of the primary forces, the weighted drums are made to revolve at twice the speed of the crankshaft. In this way the secondary forces are equilibrated and the engine runs with the smoothness characteristic of a six-cylinder engine, while the advantages of the four-cylinder engine in simplicity, lower cost, greater economy and smaller engine space are retained.

The engine has a detachable cylinder head on which is mounted the overhead rocker for the operation of the valves, and these are housed within an enclosing cover. Figs. 23 and 24 show the rockers, valve tappet system and the camshaft, on which the cams are ground out of the solid. The whole of the arrangements have been designed to give ample and easy facilities for adjustment when necessary. To attain the most efficient temperature conditions for effective vaporisation as soon as possible after the engine is started a hot spot is created by leading exhaust gases to the place where the petrol vapour strikes as it passes into the induction pipe, and water is passed from the top of the radiator through a thermostat into the jacket surrounding the induction pipe. The thermostat consists of an all-metal bellows with a valve above it. The bellows responds to small changes of temperature within its working limits, and so controls the circulation of water through the radiator. In hot weather the exhaust gas heating is not required, and provision is therefore made to shut off the exhaust gases by a simple adjustment of a valve by slackening a nut on its spindle, closing the valve and resetting the nut. The thermostatic control only allows water to pass when the temperature conditions are raised to suit efficient vaporisation, and comes into action immediately the jacket water temperature reaches a predetermined value. No circulation takes place in the radiator until this value is attained. In extreme heat or cold the engine thus runs with equal satisfaction, and as the radiator capacity is ample the control prevents overheating and excessive cooling.

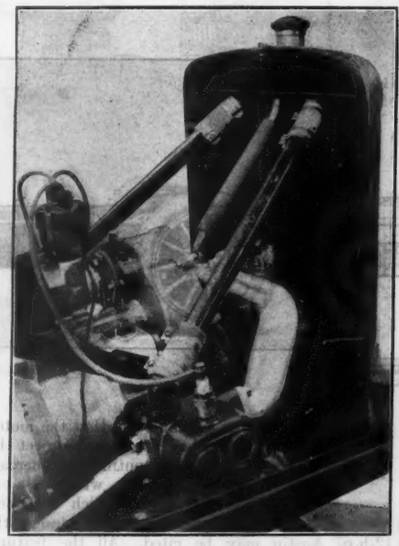


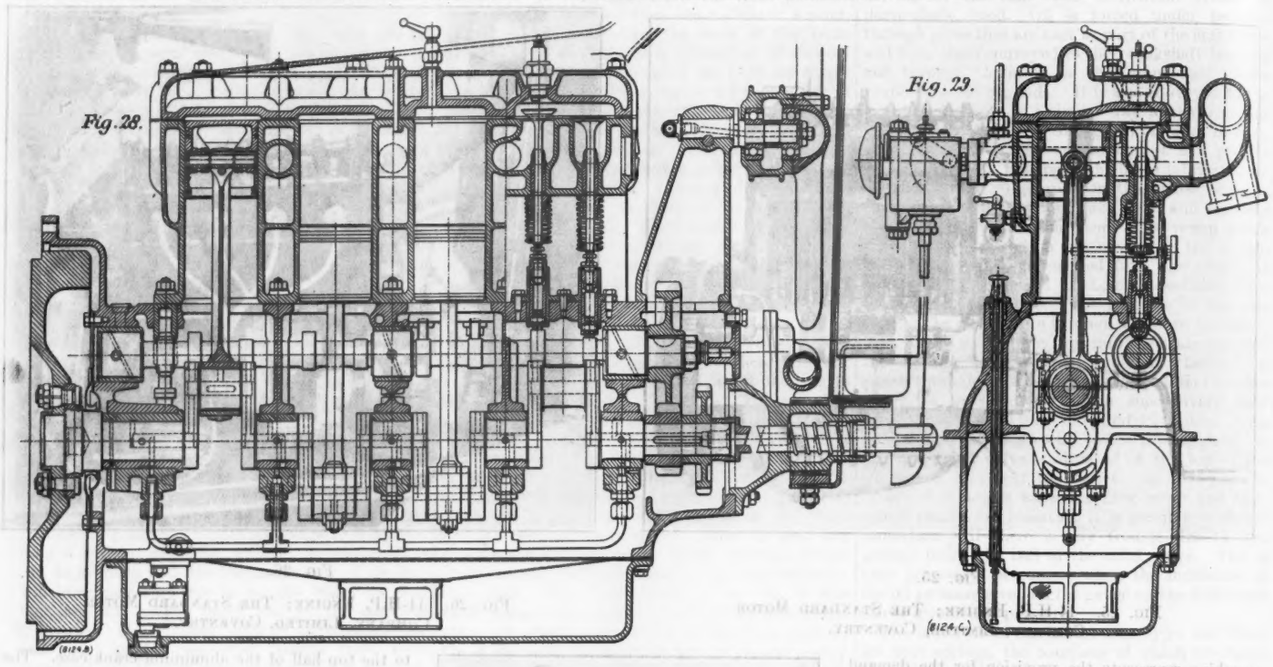
Fig. 27. 7-H.P. Engine and Cooling System; Jowett Cars, Limited, Idle, Bradford.

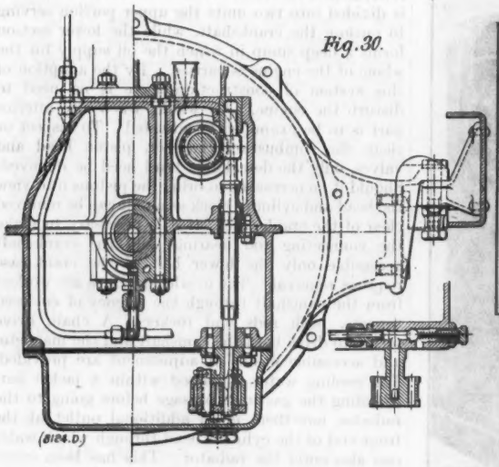
The engines of the two models produced by the Standard Motor Company, Limited, of Coventry, are shown in the illustrations, Figs. 25 and 26, on this page. In each case overhead valves are provided. The 14-h.p. unit, Fig. 25, has a bore and stroke of 75 mm. and 110 mm. respectively. The main cylinder casting, formed as a block with a detachable head in which the inlet and the exhaust valves are located, is secured by six studs and nuts to the top half of the aluminium crank-case. The lower half of the crank-case, also made of aluminium, is divided into two units the upper portion serving to enclose the crankshaft, while the lower section forms a deep sump in which the oil supply for the whole of the engine is carried. By the adoption of this system of construction there is no need to disturb the engine, as a whole, when any interior part is to be examined or adjusted. To inspect or clean the combustion chamber, piston head and valves, only the detachable head need be removed. Should it be necessary to bring the pistons into view the head and cylinder block as a unit can be removed clear of the crank-case. If it is necessary to make the connecting rod bearings and the crankshaft accessible only the lower half of the crank-case requires removal. The overhead valves are worked from the camshaft through the agency of enclosed tappets, push rods and rockers. A chain drive serves to drive both the camshaft and the magneto, and accessible means of adjustment are provided. The cooling water is passed within a jacket surrounding the gas inlet passage before going to the radiator, but there is an additional outlet at the front end of the cylinder head through which water can also enter the radiator. This has been introduced to prevent the formation of pockets of steam or water at high temperatures, which might cause localised overheating and unsatisfactory running under strenuous conditions.

The smaller engine has a bore and stroke of 68 mm. and 90 mm., respectively. This engine has many points of similarity with the larger unit, but the enclosing of tappets and valve gear is not resorted to, and the cooling water outlet is taken from the front of the cylinder head directly to the top of the radiator instead of from the centre of the length and to one side, as is the case with the other unit. Another point of dissimilarity is in the lubrication system. The gear type of pump of the larger engine is replaced in the 11-h.p. engine by a revolving disc at the rear end of the crank-case. This throws the oil from the sump, of which its casing forms a part, and the lubricant is caught on sloping galleries and conveyed to troughs under two of the crankshaft webs. These have four dippers attached to them which lift a small quantity of oil at each half revolution, and by throwing it against the wall cause the persistence of a mist of oil from which deposits occur on the cylinder walls, big end bearings and crankshaft. A direct supply for the disc chamber is taken, to the main bearings

12-H.P. AUSTIN MOTOR CAR AT THE OLYMPIA EXHIBITION.

CONSTRUCTED BY THE AUSTIN MOTOR COMPANY, LIMITED, LONGBRIDGE, NEAR BIRMINGHAM.





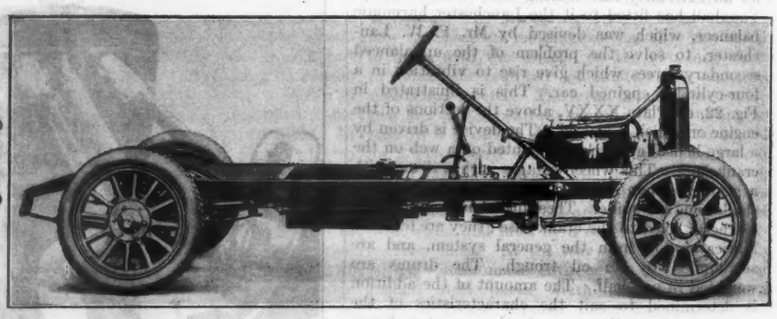


FIG. 31.

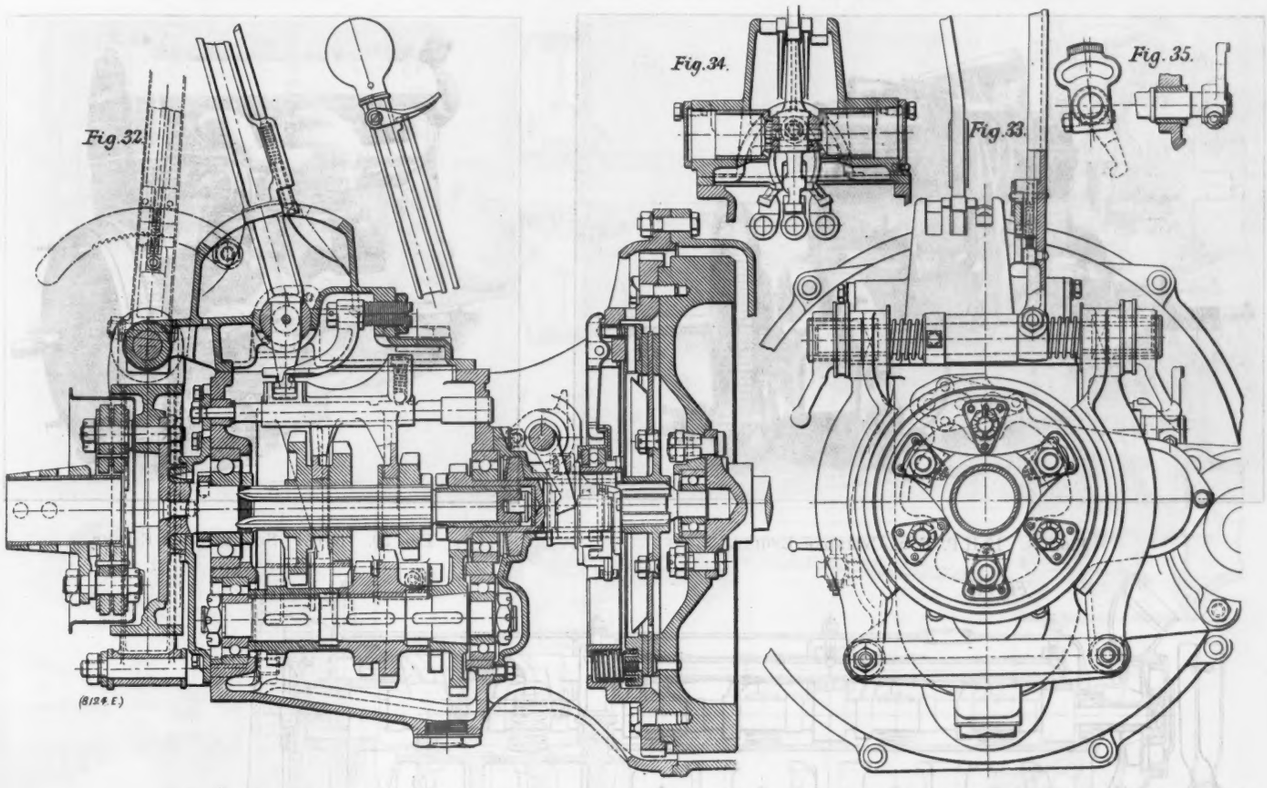
and a portion of that taken to the front bearing is carried into the chain case.

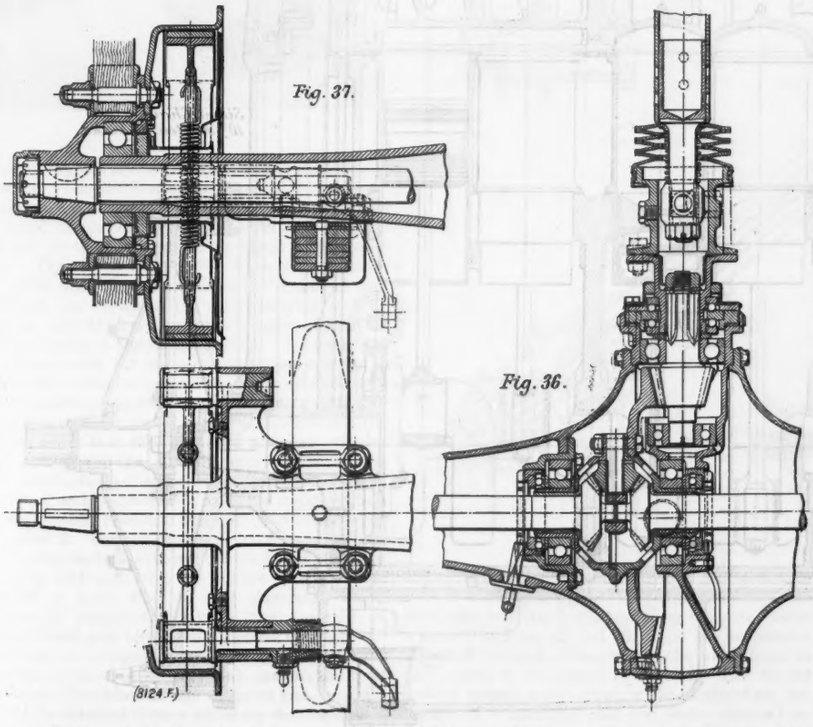
The 7-h.p. Jowett, built by Jowett Cars, Limited, of Idle, Bradford, has two horizontally-opposed cylinders of 65 mm. bore and 101·5 mm. stroke. The illustration, Fig. 27, on page 585, shows the engine unit and the cooling system. The engine is of compact arrangement and has side-by-side valves. The timing and magneto drives are enclosed within a casing in the front of the engine. The new induction pipe system is clearly shown in the illustration. The flow of cooling water from the cylinders is divided between pipes conveying it directly into the top of the radiator and through another, connecting both water jackets, which is carried to the front of the engine and the outlet from which is also taken to radiator. Within this pipe system there are the two induction pipes conveying the mixture to the inlet valves from the carburettor which is erected right in front of the engine and just behind the radiator. By this construction an inlet system is obtained, in which the gases are heated but cannot attain too high a temperature, and the benefits accruing from its adoption are said to be considerable.

As an example of what the motor manufacturers have done to meet the demands of that continuously increasing body of motorists, who seek a car of medium power which embodies many of the comforts afforded by good design, the 12-h.p. Austin may be cited. All the features that have proved successful in the larger model manufactured by the Austin Motor Company, Limited, of Longbridge, near Birmingham, have been embodied in this smaller-powered machine, the illustrations of which are given on the present and opposite pages. The details of the engine are shown in Figs. 28 to 30, while Fig. 31 gives a view of the assembled chassis. The four-cylinder engine, which is built *en bloc*, has a total capacity of 1,660 cub. cm. The cylinder dimensions of 72 mm. bore and 102 mm. stroke give an R.A.C. rating of 12·8 h.p., but 20 h.p. may be obtained with the engine on brake test when running at 2,000 r.p.m. The pistons are made of aluminium and have two rings at the top and a scraper ring at the foot. The crankshaft is well supported with five bearings, and the camshaft is made wide at its three bearings to obtain ample bearing surface. The camshaft, like the magneto, water pump and dynamo, is driven by silent chain. All the valves are on the one side of the engine, and the opening of side covers gives entry for the adjustment of tappets. The head of the engine is detachable, and thus the decarbonisation of the piston heads is easily accomplished, and the valves can also be got at for regrinding by the removal of the head. An Autovac is provided, as the petrol tank below the driver's seat is below the level of the carburettor. The suction of the engine is used to draw petrol into the Autovac mounted high on the dashboard, from which it falls to the float chamber. For lubrication the oil is drawn through a large gauze filter in the crank-pit, and is fed into a gear pump which is rotated by motion given to its shaft by a worm on the end of the camshaft. The oil is conducted through a pipe system to the channels in the crankshaft webs and pins and reaches all bearing points by radial holes in the shaft and pins. Fig. 30 shows the pump in position and shows how the pipes convey the oil to the crankshaft as well as a pipe which rises out of the crank-case at the left side, and is continued to a gauge on the dashboard from which the available pressure may be read at any time. The pressure relief valve takes the form of a spring-held ball, and is shown beside the main view in Fig. 30. The level of oil in the sump can be detected at any time by means of a dipper rod shown at the left side of the cross-section of the engine, Fig. 29. The relationship of the component parts of the car on the chassis is indicated in Fig. 31, from which it will also be seen that the clutch and gear-box are mounted with the chassis as a complete unit. The clutch is of the single-plate

12-H.P. AUSTIN MOTOR CAR AT THE OLYMPIA EXHIBITION.

CONSTRUCTED BY THE AUSTIN MOTOR COMPANY, LIMITED, LONGBRIDGE, NEAR BIRMINGHAM.





type and the gear combinations give four speeds ahead and one reverse. A hand-operated brake is mounted beside the gear-box. The operation of this brake can be readily seen in Fig. 34. The two-brake blocks can be swung into and out of action on centres at their ends which are situated on an arm below. The motion for this action is obtained from the hand lever on the shaft above, the threads on which cause the actual movement out and in of the brake blocks. Adjustment is simple, as nuts are provided at each end for the location of the blocks. The drive is continued through flexible fibre discs to the open shaft with a flexible joint and a concertina grease container at its end. This is seen in Fig. 36.

The final drive is by helical bevel gears mounted on ball bearings, and the back axle is of the semi-floating type, an example of which has been described already. The construction of the pedal-operated brake on the rear wheels is shown in Figs. 36 and 37.

There are two ways of approaching the problem of producing light cars. The first is to reduce the weight of the heavy parts of a vehicle of heavier design. This may be effected by making the parts out of stronger material that the common metals used on the first car, or to cut out part of the material from places where it is least required to withstand stresses. This is, at best, a problem whose solution largely depends on the application of the trial and error process, and some time must elapse before all the gradual changes are effected which must precede the stabilisation of the design. With such a scheme in use standardisation is only possible after long periods in testing out whether the elimination of certain parts of the weight is going to affect seriously the reliability and the account for maintenance. Another and a much more sound method is to set out on the production of an entirely new design, and to begin the consideration with the fixed purpose in view of keeping down the weight in reasonable balance between all the parts. In dealing with the design of a light car on this method, the bodywork should be standardised to the same extent as the components of the machinery, and lightness achieved in its construction may prove more acceptable in the design as a whole than the reduction of chassis weight without any thought being given to the bodywork, which is the common process. Among those who have set out with a fixed determination to effect a reasonable compromise between the weights of all the constituent elements of a motor car to obtain lightness, the firm of A. C. Cars, Limited, of Thames Ditton, may be considered as one of the most representative. In Figs. 38 to 40, on page 588, and Figs. 41 to 47, on page 589, are shown the details of the engine, back axle, brakes, steering and dynamo and magneto drive. Although the system of construction of the body is not

ENGINES AT THE OLYMPIA EXHIBITION.

CONSTRUCTED BY A.C. CARS, LIMITED, THAMES DITTON.

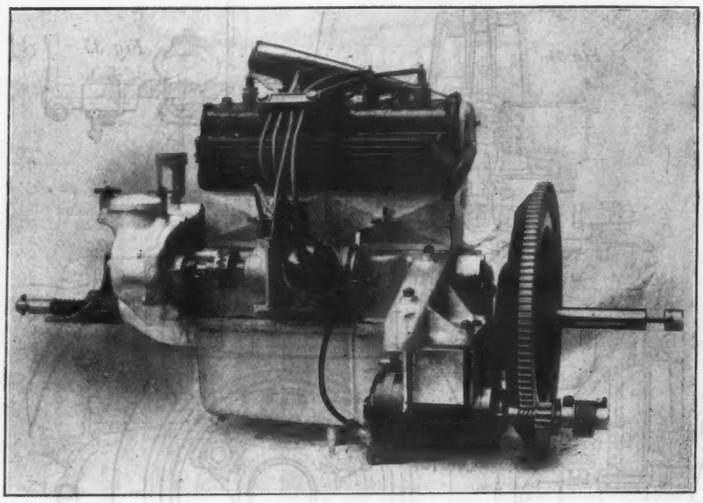


FIG. 38. 12-H.P. FOUR-CYLINDER ENGINE.

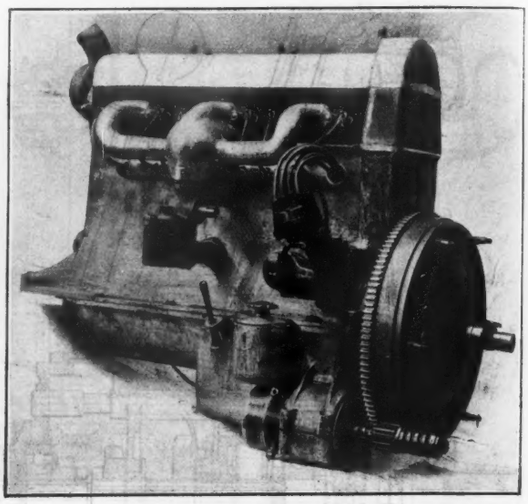
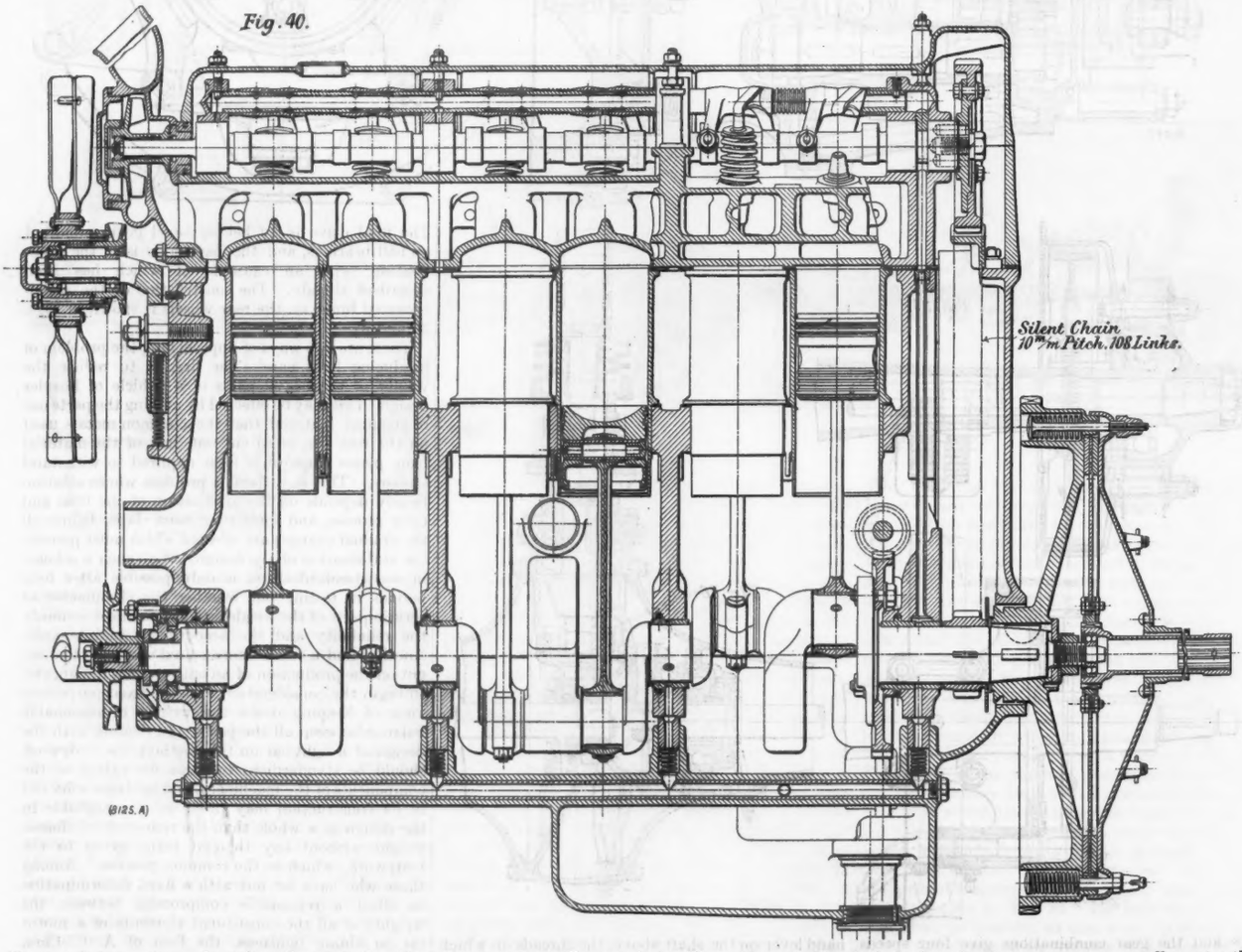


FIG. 39. 16-H.P. SIX-CYLINDER ENGINE.

Fig. 40.

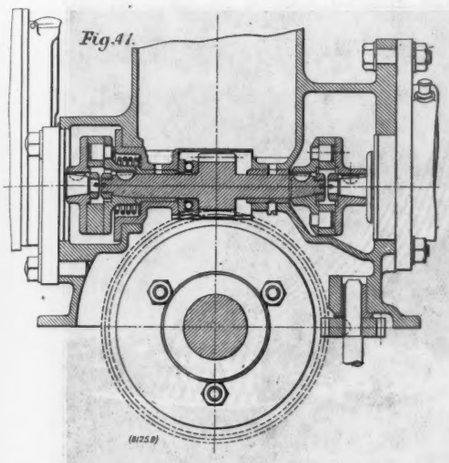


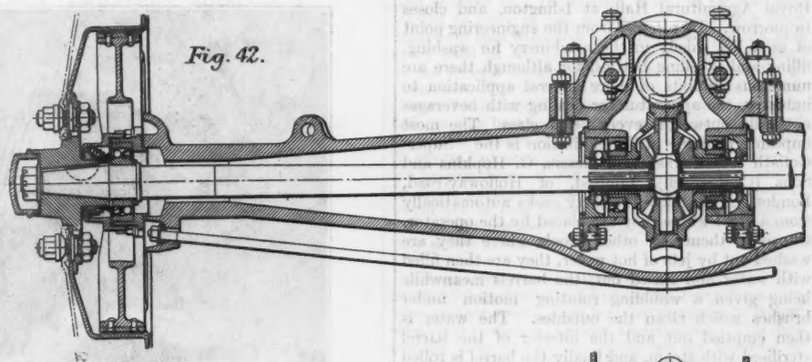
illustrated, it must not be taken that it is devoid of interest. Redundant timber has been removed with care and due consideration of the stresses. Moreover, sheets of an aluminium alloy are used in place of the usual sheet steel for the panelling, which covers the outer part of the wooden structure.

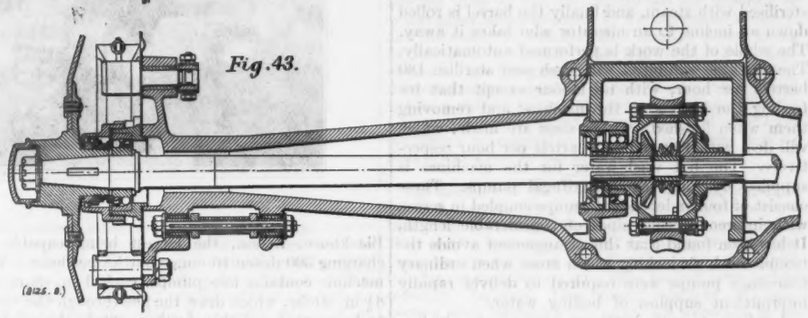
The engines illustrated in Figs. 38 and 39, annexed, are the two standard engines installed in A.C. Cars. The first is a 12-h.p. four-cylinder unit which is cast monobloc and provided with a separate air-cooled exhaust manifold. It has a detachable bend which gives access to the water jackets for cleaning purposes as well as to the cylinders and valves. The valves are totally enclosed, and the camshaft for their operation is provided with three bearings and is driven by a silent chain. The valve tappets are provided with rollers at their ends and have good guides. Adjust-

DETAILS OF 16-H.P. MOTOR CAR AT THE OLYMPIA EXHIBITION.

CONSTRUCTED BY A.C. CARS, LIMITED, THAMES DITTON.







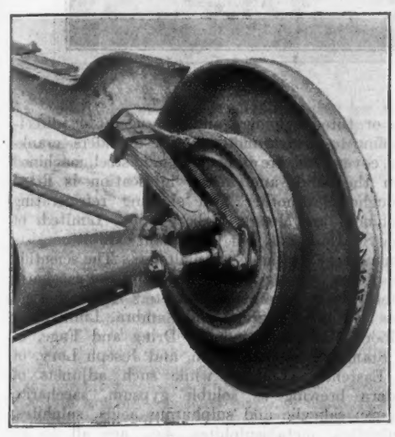
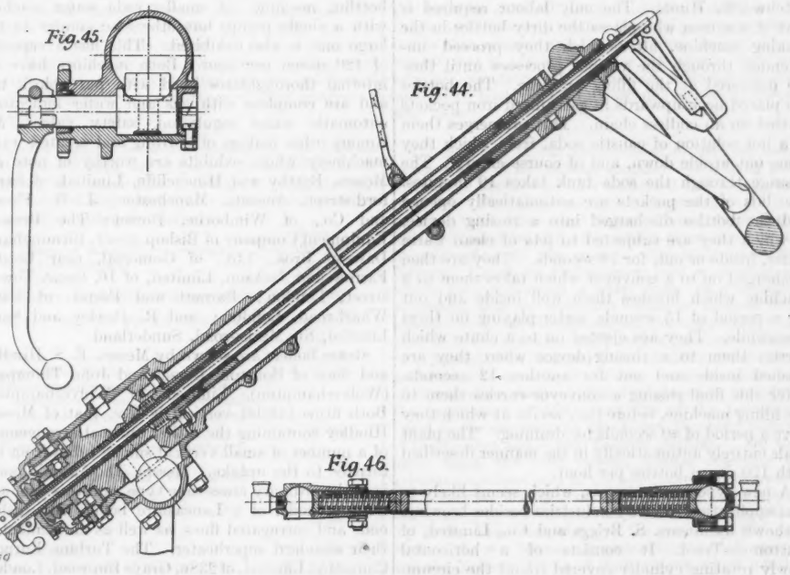


FIG. 44.



ment of tappets is effected by means of a screw and locknut. The lubrication is obtained by pressure feed from a gear pump to all engine bearings through a drilled crankshaft, but the piston and gudgeon pin receive their lubrication by splash in the usual way. The second engine, Fig. 39, is a six-cylinder one of 16 h.p., of which some of the details of construction are shown in the accompanying section, Fig. 40. For the cylinders of this engine steel liners are inserted in an aluminium casting. They are only in contact with the surrounding jacket casting at their lower ends, the upper ends being spigoted into the combustion chambers formed on the detachable monobloc cylinder head. By this construction the cooling water is in direct contact with the cylinder wall throughout the entire length of the stroke. The combustion chambers are of dome shape, machined and polished. Within the upper section of the cylinder head the camshaft and rocket gear are encased. For the camshaft drive a silent chain is provided and an automatic adjustment takes up the wear and maintains the correct tension. The flywheel is made from a steel stamping, which process of manufacture avoids the presence of casting faults and blowholes. Forced feed lubrication from a submerged pump is carried through channels in the foot of the crank case to the four bearings. The drive for the magneto and dynamo, Fig. 41, is obtained from a wheel on the crankshaft through a worm shaft above, and the motion so obtained is communicated through flexible couplings at each side to the two electrical machines.

A fabric-faced clutch carries the drive through to a spherical type of universal coupling at the front end of the enclosed propeller shaft. The gear-box is situated above the differential casing, with which it forms a single unit. Three speeds and reverse are provided, and the final drive to the back axle is by a worm and wheel. The arrangement of the back axle and the drum brakes on the rear wheels is shown in Figs. 42 and 43, while the suspension system at the back of the car and the brake drum on back wheel is illustrated in Fig. 44. The second braking system is not shown in the illustrations, but consists of a hand-operated disc brake mounted on the rear end of the worm shaft which gives the drive to the differential. Steering is effected by the Marles cam system. In this the motion from the steering wheel is given to a cam track in the steering-box. The track consists of two helical grooves and a roller is fitted freely in them, so that it can ride on either face of the grooves. As the track is turned the cam is tilted to either side of its normal position, and the motion thus given to the pin on which it is centred is carried through to the steering arm. The construction of the system is shown in Figs. 45 and 46, while Fig. 47 shows how provision is made to take up wear in the steering connections by means of spring adjustments.

(To be continued.)

A QUICK-SETTING LIME PARTITION BLOCK.—A form of block suitable for partition work has been developed in the United States which has some interesting characteristics. The material is composed of 5 parts by volume of ground quick lime, 10 parts of slaked lime and 1 of wood fibre. The block can be removed from a mould in 10 minutes and in 20 minutes can be handled. After 7 days it has a compression strength of 100 lb. per square inch. It can be sawn and nails can be driven into it.

THE BREWERS' EXHIBITION.

The fortieth annual exhibition of the Brewing and Allied Trades opened last Saturday at the Royal Agricultural Hall, at Islington, and closes to-morrow. Its interest from the engineering point of view lies chiefly in the machinery for washing, filling and labelling bottles, for although there are numerous exhibits of more general application to industry, the apparatus for dealing with beverages naturally outweighs every other class. The most imposing machine in the exhibition is the "Super-Goliath" cask washer of Messrs. G. Hopkins and Sons (Clerkenwell), Limited, of Holloway-road, London. This takes the dirty casks automatically from a stool where they are placed by the operator, transfers them to other stools where they are washed out by jets of hot water, they are then filled with water and rinsed out, the barrels meanwhile being given a wobbling rotating motion under brushes which clean the outsides. The water is then emptied out and the interior of the barrel sterilised with steam, and finally the barrel is rolled down an incline to an operator who takes it away. The whole of the work is performed automatically. The machine exhibited will wash and sterilise 180 barrels per hour, with no labour except that for feeding the barrels to the machine and removing them when finished. Other sizes are made, which will deal with 100 and 240 barrels per hour respectively. The hot wash-water for the machines is supplied by four-stage centrifugal pumps. These consist of four independent pumps coupled in series, with interconnecting pipes of considerable length. It has been found that this arrangement avoids the trouble with air-locking which arose when ordinary four-stage pumps were required to deliver rapidly intermittent supplies of boiling water.

A fully automatic bottle-washing plant, which is exhibited for the first time is to be seen on the stand of Messrs. L. Lumley and Co., Limited, of Letchworth, Hunts. The only labour required is that of one man who places the dirty bottles in the soaking machine, after which they proceed unattended through the various processes until they are delivered at the filling machine. The bottles are placed neck upwards in galvanized iron pockets carried on an endless chain. This submerges them in a hot solution of caustic soda, from which they come out upside down, and of course empty. The passage through the soda tank takes 10 minutes. The lids of the pockets are automatically opened and the bottles discharged into a rinsing device, in which they are subjected to jets of clean warm water, inside or out, for 10 seconds. They are then discharged on to a conveyor which takes them to a machine which brushes them well inside and out for a period of 15 seconds, water playing on them meanwhile. They are ejected on to a chute which carries them to a rinsing device where they are washed inside and out for another 12 seconds. After this final rinsing a conveyor carries them to the filling machine, before they arrive at which they have a period of 80 seconds for draining. The plant deals entirely automatically in the manner described with 120 dozen bottles per hour.

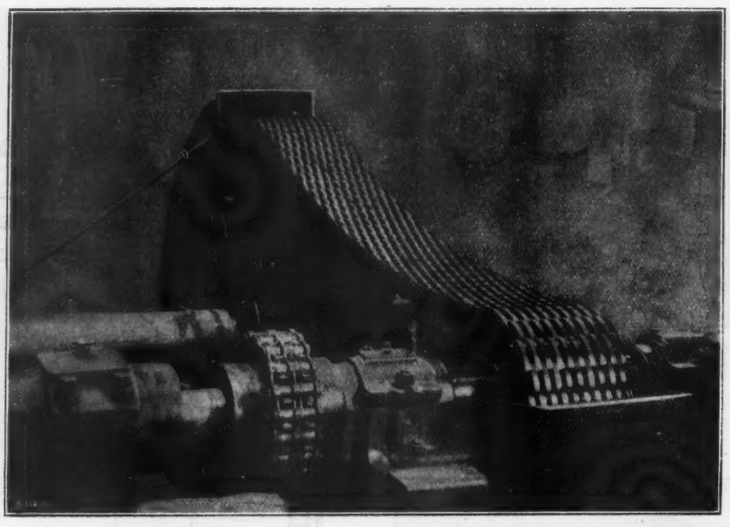
A new type of filter-press, which seems likely to find application in many industries besides brewing, is shewn by Messrs. S. Briggs and Co., Limited, of Burton-on-Trent. It consists of a horizontal slowly rotating cylinder covered round the circumference with filter-cloth. Yeast to be filtered is led into a tank in which the drum rotates. One of the trunnions of the drum is hollow and is connected to a vacuum pump, which maintains a vacuum of about 28 in inside the drum. The external atmospheric pressure forces the beer through the filter cloth into the interior of the drum, and the yeast which adheres to the surface of the drum is scraped off by an inclined fixed copper plate and led away by a shoot. The yeast is pressed dry by atmospheric pressure only, so that no rupture of the yeast cells occurs and the beer comes away without any "yeast bitten" flavour. The filter cloth is cleaned by reversing the pump and forcing liquid outwards through the cloth, and the whole apparatus is readily sterilised when required.

Several soda water machines are shown by Messrs. W. Meadowcroft and Son, Limited, of Regent-street, Blackburn, Lancs., the largest being capable of charging 500 dozen 10-ounce bottles per hour. The machine contains two pumps, each 3 in. diam. by 8½ in. stroke, which draw the gas through the water to be aerated and then further agitate the mixture under pressure before delivering it into an 18-gallon heavy gunmetal cylinder ready for the use of the bottling machine. A smaller soda water machine with a single pump, but otherwise similar to the large one, is also exhibited. This has a capacity of 120 dozen per hour. Both machines have all internal thoroughfares lined with pure block tin, and are complete with gas and water indicators, automatic water regulation, safety valves, &c. Among other makers of bottling and aerated water machinery whose exhibits are worthy of note are Messrs. Bratby and Hincheliffe, Limited, of Sandford-street, Ancoats, Manchester; J. W. Flower and Co., of Wimborne, Dorset; The Brewers Equipment Company of Bishop-street, Birmingham; Dawson Bros., Ltd., of Gomersal, near Leeds; Farrow and Jackson, Limited, of 16, Great Tower-street, London; Barnett and Foster, of Eagle Wharf-road, London; and R. Powley and Sons, Limited, St. Marks-road, Sunderland.

Steam boilers are shown by Messrs. E. S. Hindley and Sons of Bourton, Dorset and John Thompson (Wolverhampton), Limited, of Wolverhampton. Both firms exhibit vertical boilers, that of Messrs. Hindley containing the rather unusual arrangement of a number of small vertical smoke tubes from the furnace to the uptake. Messrs. Thompson's boiler is of the ordinary cross-tube type, and this firm also shew a model of a Lancashire boiler with dished ends and corrugated flues, as well as an element of their standard superheater. The Turbine Furnace Company, Limited, of 238B, Grays Inn-road, London, shew a furnace suitable for Lancashire and other boilers. The grate surface is composed of numerous small castings covering the upper surfaces of air troughs, and so arranged as to give an even distribution of air through the fire. Draught is provided for by steam jets at the entrance to the air-troughs. The Crosthwaite Engineering and Furnace Company, Limited, of York-street, Leeds, also exhibit a forced draught furnace for hand-fired boilers, and in addition a mechanical stoker for internally fired boilers.

Ice-making and cold storage machinery forms a prominent exhibit of Messrs. H. J. West and Co., Limited, of Grays Inn-road, London, who shew a number of compressors for both the ammonia and carbon-dioxide systems. The CO_2 compressors are a new design with a refrigerating capacity of 5 tons per cylinder. They are made with either one, two or three cylinders and arranged for direct-coupling to electric motors. The cylinders, crank-case, covers, &c., are all made of mild steel, machined from the solid, and forced lubrication is fitted throughout. Another firm shewing refrigerating machinery are Messrs. Robert Boby, Limited, of Bury St. Edmunds, but their main exhibit consists of machinery for the use of maltsters. The scientific side of the brewing is catered for by the saccharometers, microscopes, alcoholimeters, &c., of such firms as Messrs. Negretti and Zambra, Limited, of Holborn Viaduct, London; Dring and Fage, of 56, Stamford-street, London, and Joseph Long, of 43, Eastcheap, London, while such adjuncts of modern brewing as soluble gypsum, saccharin, tartaric, salicylic and sulphurous acids, sulphites, bisulphites, metabisulphites, &c., are all to be obtained from the various chemical manufacturers who are represented at the exhibition.

"COVENTRY" CHAIN-DRIVE FOR ROLLING MILL.



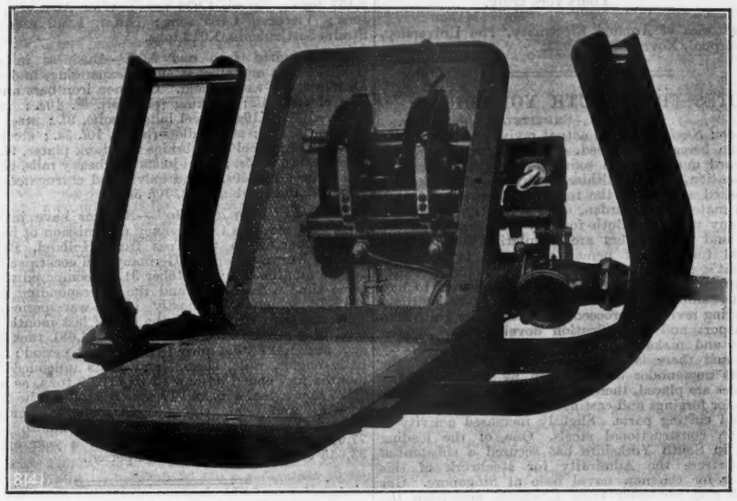
THE "COVENTRY" CHAIN DRIVE.

The accompanying illustration shows a chain drive recently supplied by the Coventry Chain Company, Limited, Spon End Works, Coventry, to the Grovesend Steel and Tinplate Works, of Gorseinon. The drive includes a chain coupling of the type of which we gave a short description in our issue of December 30, 1921 (page 886). The power transmitted is 150 h.p., the reduction being from 250 to 50 revolutions per minute. The chain is of 2½ in. pitch and is known as a 9 × 10 combination, these figures indicating the number of blocks placed side by side in alternate rows, and assembled so as to make an overall width of chain of 12·6 in., over the ends of the rivets. The actual width over the links is 11·5 in. The breaking strain for this chain is 168,000 lb., and the effective rivet wearing area amounts to 4·66 sq. in. The chain weighs 65·4 lb. per foot run. The example is composed of 118 pitches and the centres of the gears are 79·07 in. apart. The driving sprocket is of mild steel, case-hardened, and has 17 teeth, the boss being bored to 5 in. The driven sprocket has 85 teeth. It is of cast iron, and the bore is 12 in. In the coupling which is shown on the driving shaft in the foreground, transmission is effected by a duplex roller chain, sprocket-teeth being cut on both the coupling ends, the central links passing between the two faces. The coupling allows a good deal of flexibility and permits of the transmission of large powers through relatively small sizes of chain owing to the drive being distributed over a large number of pins.

British Chamber of Commerce for Italy.—This Chamber of Commerce has opened an office at 12, Nicholas-lane, E.C. 4, where it is represented by Mr. C. A. Radice, late of the Indian Civil Service.

AIR-BREAK GATE-END CIRCUIT-BREAKER.

CONSTRUCTED BY MESSRS. GEORGE ELLISON, ENGINEERS, BIRMINGHAM.



A NEW design of gate-end circuit-breaker for use underground in collieries, which has recently been introduced by Mr. George Ellison, of Perry Bar, Birmingham, is illustrated above. A breaker of this kind is used at gate-ends and controls the circuit of a trailing cable leading, for instance, to a coal cutter. The breaker is of the air-break type which has advantages of simplicity and convenience for work of this type, over an oil-immersed breaker. An appliance for this duty must be of robust construction and capable of withstanding rough usage, and the breaker is mounted in a heavy explosion-proof cast-iron box mounted on skids. The apparatus is naturally somewhat heavy owing to the liberal use of material in its construction, but the skids enable it to be transported without difficulty even over rough ground.

The circuit breaker is of the magnetic blow-out type with a series connected magnetic field. It can be used for either direct current or alternating current. It is fitted with no-volt and overload releases and time lags. The various parts of the breaker are assembled on a cast-iron frame which is bolted in the casing, and the complete breaker with its releases and time lags can easily be taken out for overhaul when necessary. The handle is a heavy gun-metal casting and is limited in its travel by stops so that no undue stress can be thrown on the internal moving parts. The single handle which serves for opening and closing the breaker is of the "free" type and becomes independent from the breaker when overload conditions prevail. The trip adjustment and time-lag devices are inside the case, so that they cannot be interfered with by unauthorised persons.

The socket connected from the trailing cable is mounted on the casing as will be seen from the figure, and the plug and socket connector is contained in gun-metal casings which prevent the withdrawal of the plug when the breaker is closed. The fixed contact half of the connector is provided with a screw cap which may be locked in position when the plug is not in use. The plug contacts are of Ellison's patent spring type, comprising spears of copper rod which enter sockets made of phosphor-bronze spring contained in cylindrical blocks. An efficient earthing connection is arranged for in accordance with Home Office regulations. The plug connector may be arranged to be inserted one way only, or a reversible plug can be supplied to change the direction of rotation of the motor. The plug connector will take cabtyre sheathed cable up to 248/·018, which will carry something over 60 amperes on I.E.E. rating. The breaker will carry a heavier current than this. The whole design fulfils all the requirements of colliery duty and complies with the Coal Mines Act.

INDUSTRIAL NOTES.

MR. FRANK HODGES, on his return from Canada, made a statement in regard to the miners' wages agreement to which we referred in our last issue, and said that the men's claim is that for every 100*l.* of wages at the standard, profits should receive 13*l.*; the surplus realised, after standard wages, standard profits and other costs of production have been met, shall be divisible also as to 100*l.* wages and 13*l.* profits. The division is to be the same, therefore, both as to the standard and the surplus. He added that the Federation does not ask the public to consider profits in the light of any particular two months working; it bases its claim on the broad fact that the normal working of the agreement over a reasonable period of trade gives the owners an extremely good rate of profits, whilst the men are left considerably below their pre-war standard of living. The miners ask for consideration of the claim for a reasonable living wage, on the ground of their lowered standard of living, the risk and hazard of their calling, and the importance of their product to the national economic life.

The coal output, costs and profits for the quarter ended June 30, 1923, are given by the Board of Trade as follow, the particulars relating to undertakings which produced about 95 per cent. of the total quantity of coal raised during the period:—

	Tons.
Tonnage of saleable coal raised ...	65,527,464
Mine consumption	3,953,223
Miners' coal	1,479,785
Tonnage disposable commercially	60,094,456

Costs of Production per Ton Disposable Commercially.

	s.	*d.*
Wages	11	11·46
Stores and timber...	2	2·25
Other costs (management, salaries, insurances, repairs, office and general expenses, depreciation, &c.)	2	6·64
Miners' Welfare Fund contributions	0	1·09
Royalties (including the rental value of freehold minerals where worked by the proprietor)	0	6·38
Total costs	17	3·82
Deduct proceeds of miners' coal...	0	1·25
Net costs	17	2·57
Commercial disposals	20	5·21
Credit balance	3	2·64

The number of workpeople employed was 1,102,380; the output per man-shift worked amounted to 17·90 cwt., and the earnings per man-shift worked to 9*s.* 9·77*d.*

As announced on page 560 *ante*, in the matter of the boilermakers' dispute, the mediation committee appointed by the Trades Union Congress met last week, in London, representatives of the Federation of Engineering and Shipbuilding Trades and of the United Society of Boilermakers and Iron and Steel Shipbuilders. At the close of the meeting it was stated that "after prolonged discussion it was decided to continue the negotiations with the Employers' Federation, with a view to arranging immediate consultations as between the employers and the boilermakers Society." Other conferences have been held since, and early in the week it was announced that one between the boilermakers and employers was to take place to-day. The last meeting of the employers with the boilermakers was held on June 22. The dispute, it will be remembered, started as early as last March, and it affects a large number of men belonging to various trade unions, and every yard in the country. Speaking last Monday, at the annual dinner of the Birkenhead Chamber of Commerce, Mr. W. L. Hichens, chairman of Messrs. Cammell Laird and Co., Limited, said that his company had done its best to secure orders, and had a fair and reasonable amount of work on hand, but, unfortunately, its efforts had been largely frustrated by the action of the boilermakers; it was their action that had created so much unemployment in the town. He hoped it would not be long before the boilermakers recognised that in the interest of reason, justice and humanity they should return to work.

Mining operations in Western Australia, says *The South African Mining and Engineering Journal*, quoting from another source, have been handicapped by labour conditions under a Labour Government. This has affected them in two directions, one the fostering of extravagant labour demands by a sympathetic Ministry, and the other the withdrawal of English money owing to the fear of further class legislation. But these obstacles to progress are slowly clearing away. Australia under present world conditions is being forced to take a wider view, and the endeavour, made after the war, to create an artificial rate of wages and other local conditions by restrictive legislation is far less popular than it was a year or two ago.

The secretary of the London Iron and Steel Exchange, Limited, reports that British steel-makers are now better off for orders than for many months past. Most works, however, are still operating at far below capacity, the principal exception being the sheet and tin-plate manufacturers who have booked large orders recently. Japanese Government tenders in connection with reconstruction work are expected to be given out shortly, and it is hoped they will provide some attractive business for the British steel trades. On the other hand Continental competition is still keen. The position on the Continent continues difficult; in Belgium the labour situation is again causing anxiety, and in that country and in Luxemburg the outlook as regards fuel is precarious. For this reason the Continental manufacturers of finished material are disinclined to book for far forward delivery or to accept large orders.

The question of the reduction of 6*s.* 6*d.* per week in the wages of the railway shopmen—this being part of the war bonus—remains undecided and also rather involved. The Amalgamated Engineering Union, together with other craft unions, have informed the railway companies that they cannot agree to any form of arbitration in the matter. For their part, the National Union of Railwaymen held a meeting at which they considered a letter from the companies suggesting that the reduction should be referred to a special court, and decided to ask the companies what were to be the functions and power of the court referred to. Further, the National Union of Railwaymen want arbitration to cover both the war bonus question and all outstanding matters regarding shopmen, including the application of the award 728 of the Industrial Court to the shopmen on the Great Northern section of the London and North Eastern Railway. On the other hand, the craft unions, besides objecting to arbitration, object also to the application of the award 728. Another matter under consideration is the application made by a number of craft unions for consolidating in the basic rate of wages the remaining 10*s.* per week of the war bonus. Presumably, the craft unions and the National Union of Railwaymen, which jointly and severally deal with the railway shopmen, would remain outside this consolidation scheme. Quite apart from the railway shopmen's case, the question of reduction and modification in the railwaymen's wages also remains undecided and is engaging the activities of the National Union of Railwaymen. All these various points may be cleared up by the National Wages Board for the railways which commenced sitting yesterday.

CONTRACTS.—Among recent contracts, Messrs. Armstrong, Whitworth and Co., Limited, report the following: Seven Francis type water turbines of 14,000 h.p. each, for the Newfoundland Power and Pulp Company; two Pelton wheels, each of 7,500 h.p., for the Aluminium Corporation, Dolgarrog, North Wales, for whom they are also remodelling an old Ganz wheel to increase the output to 1,800 h.p.; two Francis type turbines of 600 h.p. each, for Grafton, New South Wales; and one Francis type turbine of 180 h.p., for Thibet.

"THE MICHELL CRANKLESS MOTOR."

To the Editor of Engineering.

Sir,—Referring to the Michell crankless motor, described in your issue of the 5th ult., it may be of further interest to observe that the resultant torque on the framing due to the inertia of the reciprocating masses may be represented by a vector rotating with the speed of the shaft. There is thus presented a mechanical analogy to the rotating magnetic field set up by symmetrically distributed coils supplied with simple alternating currents whose phasal differences are equal to the spatial differences of the coils in which they act.

The forces along the lines of reciprocation are equivalent to equal forces along the shaft axis, together with couples each having a moment whose maximum value is T, where

$$T = 2\,m\,\omega^2\,R^2 \cot a.$$

a = angle between slant and shaft.
ω = angular speed of shaft.

Each line of reciprocation represents a phase, and with N such lines, the resultant couple is equal to $\frac{N\,T}{2}$ (when N is greater than 2).

The axis of the couple continually agrees in direction with, and is opposite in sense to, the axis of the rotating centrifugal couple produced by the rotating slant.

The magnitude of the centrifugal couple is

$$\frac{M}{4} \cdot \omega^2\,(A^2 + a^2) \cot a.$$

Equating this to $\frac{N\,T}{2}$ the expression for M is quickly obtained.

Balance of torque could be obtained for a two-line engine in which the lines are separated by an angular interval 90 deg., but the forces would remain unbalanced.

I remain, yours faithfully,

E. C. Moyle.

Harris Institute, Preston, November 5, 1923.

"A METHOD OF IMPROVING THE WAVE SHAPE OF ALTERNATORS."

To the Editor of Engineering.

Sir,—I have read with interest the letter by Mr. Clinker, on page 557 of your last issue, describing the device that has been used by the British Thomson-Houston Company to reduce the effect of harmonics in some of their three-phase generators. The principle of the device is, of course, entirely different from the one which Mr. Turney and I described recently before the meeting of the British Association. As Mr. Clinker says, the chief advantage that the British Thomson-Houston method possesses is that the condensers used do not have to withstand the full pressure of the supply circuit. On the other hand, the inductances have to carry the full load current of the alternators, so that they will have to be designed for this current and will, therefore, be correspondingly expensive. In the arrangement proposed by Mr. Turney and myself the shunts will only carry a fraction of the full load current of the alternator, and the inductance coils in the shunt circuits need only be of small size. The only inductance which carries the main current is the limiting inductance, and as was pointed out in the description of the apparatus at the meeting of the British Association, where it is desired to eliminate triple frequency components of the pressure wave, the limiting inductance can be placed in the neutral of the three-phase supply, in which case it only carries any out-of-balance currents there may be between the three phases of the system. The cost of the necessary circuits, therefore, in our arrangement, is quite small. Where the device is used on high pressures it is not necessary that the condensers should be designed to stand up to the full supply pressure, as the circuits can be applied through transformers of quite small rating, if necessary.

In the arrangement described by Mr. Clinker, if the reactance of the inductive coil ($L\,w$) is large compared with the effective resistance r, the rejector circuit will offer an impedance to currents of the frequency for which it is tuned of

$$\frac{(L\,w)^2}{r} \text{ or } \left[\text{since } L\,w = \frac{1}{C\,w}\right] = \frac{L}{C\,r}.$$

$L\,w$ cannot be made too large, or the regulation of the alternator will be adversely affected, since the greater part of the load current at normal frequency has to pass through the inductive branch of the rejector circuit. Where the alternator is connected to a network of cables through which triple frequency capacity currents will flow, the impedance of the rejector circuit may, therefore, be of the same order of magnitude as that of the cable network. Under these circumstances, the reduction of the triple frequency currents brought about by the use of rejector circuits, will be relatively small. On the other hand, in the arrangement described by Mr. Turney and myself, the voltage wave of the alternator has the triple frequency component reduced to a small fraction of its original value, and the capacity current through the cable network is reduced to correspondingly small proportions, whatever the external reactance may be. The filter device described by Mr. Clinker would, I think, be difficult to apply in a case where triple frequency or other low harmonics of the pressure wave have to be eliminated. In cases where the harmonic to be eliminated is of high frequency, as in the case quoted by Mr. Clinker, the filter circuit should be more effective. There are, I believe, a number of cases where telephone interference is due to low harmonics of triple frequency or some multiple of triple frequency. In one case with which we have had to deal, the insertion of a shunt for six times the main frequency and another for 12 times the main frequency, together with a suitable limiting inductance, completely got rid of telephone disturbance.

The case referred to by Mr. Clinker in which trouble was found to be due to the 35th and 37th harmonics is, of course, a simple one to deal with by means of either device, since the condensers and inductances required are relatively small.

Yours very truly,

E. W. Marchant.

Laboratories of Applied Electricity, The University, Liverpool, November 5, 1923.

NOTES FROM SOUTH YORKSHIRE.

Sheffield, Wednesday.

Iron and Steel.—Though actual revival is still a long way from being experienced, definite signs are seen of an upward movement in some of the basic branches. An indication of the healthier conditions anticipated in the finished sections is the tendency of raw and semi-finished materials to harden, after a reaction extending over many months. Both foundry and forge iron are firmer, and steel-makers are circulating inquiries for increased tonnages of hematites. Scrap is becoming somewhat scarce, and a certain amount of anxiety exists as to future supplies should Germany continue to buy merchant ships from this country for dismantling. Engineering revival a proceeding steadily along the lines of transport and electrification development. Wagon builders and makers of railway stores are distinctly busier, and there is every indication that when the contracts now under consideration by British railway companies are placed, there will be a heavy call upon this district for forgings and castings, and all manner of steel tools and cutting parts. Slightly increased activity is shown in constructional steels. One of the leading makers in South Yorkshire has secured a substantial contract from the Admiralty for steelwork of this character for the new naval base at Singapore. Gas plant is also on order from Liverpool and from the South of England. Makers of crucible steel, twist drills and special dyes and stocks are still only moderately busy, but inquiries tend to expand, and a gratifying feature is the enlivened interest shown by some of the leading Colonial buyers. United States orders are being booked despite the damaging effect of the Fordney Tariff. The lighter trades are moving slowly forward. Continental competition has largely disappeared, being restricted almost solely to stocks in merchants' hands. Japanese stocks of Sheffield twist drills and other cutting tools were either wiped out or rendered useless by the disastrous fire following the earthquake. Samples returned to Sheffield had been caked together by the tremendous heat of the earthquake fires, and adhering to them was so much foreign matter that they were useless even for re-melting as scrap. Building trade demands are steadily in the ascendant. There is a growing market for light castings, pipes, taps and domestic fittings.

South Yorkshire Coal Trade.—Improved business at the collieries is handicapped by growing shortage of empty wagons, but otherwise the position is uniformly steady, and there is no disposition on the part either of coal-owners or merchants to do business below the recently advanced official rates. Best steam hards are an active market for export, with home trade on a moderate scale. Cobbles and nuts are stronger, while best quality slacks are in deficient supply. Virtually the whole output of best house coal is absorbed by increased contracts, spot business being confined to the lower grades. Quotations: Best handpicked branch, 31*s.* 6*d.* to 32*s.* 6*d.*; Barnsley best Silkstone, 27*s.* 6*d.* to 29*s.*; Derbyshire best brights, 27*s.* to 29*s.*; Derbyshire best house, 23*s.* to 24*s.*; Derbyshire best large nuts, 21*s.* to 22*s.* 6*d.*; Derbyshire best small nuts, 15*s.* to 16*s.*; Yorkshire hards, 21*s.* to 23*s.*; Derbyshire hards, 20*s.* to 22*s.*; rough slacks, 11*s.* 6*d.* to 13*s.* 6*d.*; nutty slacks, 10*s.* to 12*s.*; smalls, 7*s.* to 9*s.*

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

Middlesbrough, Wednesday.

The Cleveland Iron Trade.—The market keeps strong with a steady business passing, and the outlook is regarded as improving. Stocks of Cleveland pig-iron are now very low, and it needs little further increase in demand to necessitate enlargement of output. Quotations now ruling all but cover cost of production. Demand for Cleveland qualities is chiefly for home use, but a little export business is passing. No. 1 is 107*s.* 6*d.*; No. 3 g.m.b., 100*s.*; No. 4 foundry, 99*s.*; and No. 4 forge, 97*s.* 6*s.*—all f.o.t. makers' works, and f.o.b. Tees.

Hematite.—East Coast hematite is a good deal sought after, but supply is quite equal to requirements. Increase in demand, however, is anticipated, as purchasing seems likely for certain purposes for which Cleveland foundry iron is used. Further sales have been made to Sheffield, Wales and the Continent. Mixed Nos. are 100*s.* to 100*s.* 6*d.* for home and export trade, and No. 1 is 101*s.*

Shipments of Iron and Steel.—Shipments of iron and steel from the Tees during October—together with 7,638 tons loaded at Skinningrove—totalled 106,362 tons and were the heaviest since April last year. Of the 34,297 tons shipped from the port of Middlesbrough, 27,757 tons went to foreign ports and 6,540 tons went coastwise. Of the 1,989 tons of manufactured iron cleared, 1,771 tons went to foreign ports and 218 tons went coastwise; and of the 62,438 tons of steel despatched, 50,440 tons went to foreign ports and 11,998 tons went coastwise. The chief customers for pig-iron were:—Germany, 4,500 tons; France, 4,487 tons; Belgium, 4,429 tons; Denmark, 4,385 tons; Scotland, 3,440 tons; Wales, 2,400 tons; Sweden, 2,034 tons; Holland, 1,879 tons; and Italy, 1,750 tons. Once more India was the largest purchaser of both manufactured iron and steel, importing 1,305 tons of the former, and 16,227 tons of the latter. Among the other principal receivers of steel were:—Germany, 6,532 tons; Egypt, 5,583 tons; Denmark, 2,786 tons; New South Wales, 2,631 tons; Nigeria, 2,157 tons; Japan, 1,935 tons; West Australia, 1,604 tons; Victoria, 1,465 tons; Natal, 1,272 tons; and Straits Settlements, 1,012 tons.

Manufactured Iron and Steel.—Business in manufactured iron and steel is slowly expanding, and values, all round, are well upheld. Common iron bars are 12*l.*; iron rivets, 14*l.*; packing (parallel), 8*l.* 10*s.*; packing (tapered), 11*l.* 10*s.*; steel billets (soft), 9*l.*; steel billets (medium), 10*l.*; steel billets (hard), 10*l.* 5*s.*; steel boiler plates, 13*l.*; steel ship, bridge and tank plates, 9*l.* 15*s.*; steel angles, 9*l.* 5*s.*; steel joists and heavy rails, 9*l.* 10*s.*; fish plates, 12*l.* 10*s.*; and galvanised corrugated sheets (No. 24 gauge, in bundles), 19*l.* 5*s.*

Imports of Iron and Steel.—Returns have just been issued by the Tees Conservancy Commission of iron and steel imported to the Tees from Holland, Belgium, France, Norway, Sweden, Germany and coastwise for the twelve months ending October 31, as compared with the same time a year ago, and the corresponding part of 1913–14 which was mostly a pre-war period. The statistics show that up till the end of last month 14,748 tons of pig-iron arrived as against 34,681 tons a year ago, and 1,427 tons during the 1913-14 period; plates, bars, angles, rails, sheets, and joists unloaded in the months just ended amounted to 11,289 tons, as against 7,125 tons a year ago, and 19,482 tons during the 1913–14 period; and crude sheets, bars, billets, blooms, and slabs imported up till the end of last month totalled 77,612 tons, as against 54,611 tons a year ago, and 33,655 tons during the 1913–14 period.

NOTES FROM THE NORTH.

Glasgow, Wednesday.

Scottish Steel Trade.—A better and more hopeful feeling prevails in the Scottish steel trade, but despite the improved tone the demand has not appreciably increased. Employment at some works is of the very smallest, while one or two have recently booked a few orders which will help to keep plant moving—a part of it at least—for a month or two yet. Conditions' overall are not satisfactory, however, and no improvement of any note is expected until the boilermakers' dispute is settled and work in the shipyards is resumed. The prospects of the above disagreement coming to an end quite soon now are better than they were, and it is hoped that an amicable understanding may be the outcome of the proposed fresh meeting on Friday of this week between the representatives of both parties. Meantime there is little or nothing doing in ship plates, but sectional material is in better request. The black sheet makers have fairly well filled order books, but unfortunately most of the business is for light gauge sheets, and dealings in the heavier sorts are very restricted. General export trade shows signs of improvement, and prices all round are steady. The following are to-day's quotations:—Boiler plates, 13*l.* per ton; ship plates, 10*l.* per ton; sections, 9*l.* 15*s.* per ton; and sheets, 12*l.* 10*s.* per ton, all delivered Glasgow stations.

Malleable Iron Trade.—There has been little movement in the malleable iron trade in the West of Scotland during the past week. Business has been patchy with occasional bright spots here and there, but overall dealing is of the hand-to-mouth description and the outlook is uncertain. In the re-rolled steel branch of the industry fairly satisfactory conditions continue to prevail and buisness is quite good. The current quotation for "Crown" bars is 12*l.* per ton, delivered Glasgow stations.

Scottish Pig-Iron Trade.—The immediate demand for Scottish pig-iron is not very heavy at the moment, but the quantity sold forward is fairly good. Stocks on hand are large on account of the recent trade depression, and producers are in a good position to overtake any decent lines that offer. Prices are nominally unchanged, and are as follow:—Hematite, 5*l.* 5*s.* per ton, delivered at the steel works; foundry iron, No. 1, 5*l.* 5*s.* per ton; and No. 3, 5*l.* per ton, both on trucks at makers' yards.

Scottish Pig-Iron Shipments.—The shipment of Scottish pig-iron from Glasgow Harbour for the week ending last Saturday, November 3, amounted to 6,903 tons. Of that total, 6,717 tons went overseas and 186 tons went coastwise. For the corresponding week of last year the figures were 1,837 tons overseas and 345 tons coastwise, making a total shipment of 2,182 tons.

Shipbuilding.—One or two fresh contracts have lately been booked by Scottish shipbuilders, and the following are reported:—A tank steamer of 2,250 tons gross and 1,400 i.h.p., to be built by Messrs. William Beardmore and Co., Limited, Dalmuir, for the Anglo-Saxon Petroleum Company, Limited, London. The Dundee Harbour Trust have placed an order with the Caledon Shipbuilding and Engineering Company, Limited, Dundee, for a new ferry steamer of the following dimensions: Length, 150 ft.; beam, 49 ft.; and draught, 4 ft. This vessel, which is to cost 18,250*l.*, will have a speed of 10 knots, and will have ample accommodation for passengers and vehicles of all kinds. It will make the Tay crossing from Dundee to Newport (Fife) in 10 minutes.

New Glasgow Docks.—At the meeting of the Clyde Trust yesterday (Tuesday) approval was given to the minute of the Special Committee on the Shieldhall and Renfrew Dock scheme, which stated that, on the initiation

of the chairman (Sir William H. Raeburn, M.P.), the committee had under consideration whether it would be possible for the Trust to contribute towards the mitigation of unemployment distress by arranging to accelerate the execution of the work of constructing Shieldhall Dock No. 1, and a portion of the Renfrew quayage. It was agreed to approach the Government Unemployment Committee with a view to obtaining a grant towards the cost, and instruction was given for the New Works Committee to proceed with the necessary preparations. The cost of No. 1 basin will be in the neighbourhood of 1,000,000*l.*, apart from sheds and appliances, and employment will be given to between 1,500 and 2,000 men. Work will be started shortly.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Coal Trade.—Exports of coal as cargo from South Wales ports last week amounted to 529,010 tons, which was 40,000 tons less than in the previous week. The shrinkage was undoubtedly primarily due to stormy weather having kept tonnage arrivals back and disorganised the arrangements of buyers and sellers, and also the dock and railway authorities. The effect of the bad weather on the transport arrangements will be gathered from the fact that there were from 20 to 25 tips idle daily at the leading ports, chiefly because of the non-arrival of expected shipping, while there were also from 10 to 15 steamers waiting to go into loading berths but were unable to do so because the particular coals required for loading them were not available. Exports from Cardiff last week totalled 333,460 tons, compared with 369,100 tons a week earlier, from Newport 77,690 tons against 84,880 tons, from Swansea 72,530 tons against 63,180 tons, from Port Talbot 36,330 tons against 45,640 tons, and from Llanelly 9,000 tons against 6,870 tons. Shipments to France amounted to 205,520 tons compared with 220,720 tons, to Italy to 53,740 tons against 88,930 tons, and to Belgium 36,270 tons against 19,850 tons, while the United States took 4,940 tons compared with nil, and Canada 2,000 tons against 5,200 tons. For spot and prompt loading prices were generally irregular owing to the different conditions at the various collieries due to the dislocation of shipping arrangements, but for forward shipment collieries were not disposed to sell except at prices in excess of those recently accepted for delivery over next year. As a matter of fact, it is reported that a good deal of business has been concluded for next year's delivery on the basis of 28*s.* 6*d.* for best Admiralty large, 27*s.* to 27*s.* 6*d.* for seconds, and from 25*s.* to 26*s.* for Monmouthshires, and that collieries in many cases have closed their books for the time being, while those disposed to take on business want from 3*d.* to 6*d.* per ton above these levels. For prompt and spot loading the position, however, is entirely different. Many collieries though sold on paper need buyers who can take immediate delivery, so as to prevent pit stoppages, with the result that those able to take advantage of the opportunity can secure supplies of practically all classes of coal, especially Monmouthshires, at figures from 1*s.* to 2*s.* below the quoted figures of 27*s.* 6*d.* to 28*s.* 6*d.* for best Admiralty large and 26*s.* to 27*s.* for Monmouthshire large. Smalls, the output of which has been reduced by the frequency of pit stoppages, have been in none too plentiful supply, and prices range from 14*s.* to 18*s.*, according to quality.

PERSONAL.—Owing to the increased volume of orders and inquiries which Messrs. Vickers, Limited, are receiving for water turbines and accessories, a consolidation is taking place of their hydro-electric department in order to attain more compact organisation and greater promptness in correspondence, and the headquarters of the department are being established at their works at Barrow-in-Furness. Correspondence, &c., in reference to water power equipment, and hydro-electric projects of all kinds, should in future be addressed to Vickers, Limited, Hydro-electric Department, Barrow-in-Furness. Mr. W. H. Munro has been appointed chief of the department.—Messrs. Marshall, Sons and Co., Limited, Gainsborough, write to say there is absolutely no foundation for the report (circulated by certain sections of the lay press) that Messrs. Vickers, Limited, have taken over or acquired this firm. The report did not appear in ENGINEERING.

THE LATE MR. W. H. S. CRAVEN.—It is with regret that we have to record the death on Tuesday, October 30, of Mr. William Henry Saville Craven, for many years chairman and managing director of Messrs. Craven Brothers (Manchester), Limited, of the Vauxhall Works, Reddish, Stockport. Mr. Craven was born in May, 1861, and received a general education at Hardwick College, proceeding afterwards to Owens College, where, from 1877–79, he occupied himself with engineering subjects. He subsequently spent six years in practical training in Messrs. Craven's works; after which, in 1886, he was appointed assistant works manager, subsequently being appointed managing director, chairman and general manager of the firm. He was responsible for enlargements of the Vauxhall Works, and designed and superintended the company's new works at Reddish, which then covered about 7 acres. He was also responsible for the design of electric light and power stations, for the design and erection of the Great Central Railways carriage and wagon works at Dukinfield, covering about 15 acres, and for the Dairen locomotive, carriage and wagon works of the South Manchurian Railway. These works covered an area of about 12 acres. Mr. Craven was elected a member of the Institution of Civil Engineers in 1910, but had been a member of the Institution of Mechanical Engineers since 1894.

NOTICES OF MEETINGS.

THE INSTITUTION OF AERONAUTICAL ENGINEERS.—Friday, November 9, at 6.30 p.m., at the Engineers' Club, Coventry-street, W. 1. "The Soaring Flight Question," by Dr. E. H. Hankin, M.A.

THE JUNIOR INSTITUTION OF ENGINEERS.—Friday, November 9, at 7.30 p.m., at 39, Victoria-street, S.W. 1. Lecturette, "Amateur Cinematography," by Dr. C. K. Mees. Friday, November 16, at 7.30 p.m., Annual General Meeting. Saturday, November 17, at 2 p.m., visit to the Carriage Repair Depot of the Underground Railway, Acton Works, Chiswick.

THE INSTITUTE OF METALS; SHEFFIELD LOCAL SECTION.—Friday, November 9, at 7.30 p.m., in the Mappin Hall of the University, St. George's-square, Sheffield. Sorby Lecture on "Metallurgical Problems, Present and Future," by Dr. W. Rosenhain, F.R.S. Friday, November 16, at 7.30 p.m., in the Non-Ferrous Lecture Room, the University, St. George's-square. Paper on "Substitutes for Platinum," by Mr. Ernest A. Smith, A.R.S.M.

THE KEIGHLEY ASSOCIATION OF ENGINEERS.—Saturday, November 10, at 6.30 p.m., in the Assembly Room, Cycling Club, Cavendish-street, Keighley, when a paper will be given by Mr. Isaac H. Wright, A.M.I.Mech.E. Subject: "Twenty-Five Years' Progress in Machine Tools."

THE NORTHAMPTON ENGINEERING COLLEGE, ENGINEERING SOCIETY.—Monday, November 12, at 5.30 p.m., at Northampton Engineering College, St. John-street, E.C. 1. Paper on "Turbo-Compressors and Blowers," by Mr. A. J. D. Humby.

THE INSTITUTE OF METALS; SCOTTISH LOCAL SECTION.—Monday, November 12, at 7.30 p.m., in the Rooms of the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Paper on "Nickel Alloys," by Mr. D. Turner.

CLEVELAND INSTITUTION OF ENGINEERS.—Monday, November 12, in the Hall of the Cleveland Technical Institute, Middlesbrough, at 6.30 p.m., the President, Mr. H. B. Toy, will deliver his address.

THE ROYAL SOCIETY OF ARTS.—Monday, November 12, at 8 p.m.: Cantor Lecture, "The Cultivation of Cocoa in British Tropical Colonies," by Mr. Samuel Henry Davies, M.Sc., F.I.C. (Lecture I).

THE INSTITUTE OF METALS; BIRMINGHAM LOCAL SECTION.—Tuesday, November 13, at 7 p.m., in the Chamber of Commerce, New-street. Paper on "X-Rays and Crystal Structure," by Mr. H. B. Keene, D.Sc.

THE INSTITUTE OF METALS; NORTH-EAST COAST LOCAL SECTION.—Tuesday, November 13, at 7.30 p.m., in the Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. Paper on "General Scientific Brass Foundry Work," by Mr. P. Longmuir, D.Met.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—SCOTTISH CENTRE.—Tuesday, November 13, at 7.30 p.m., at the Rooms, 207, Bath-street, Glasgow; Inaugural Address by the Chairman, Mr. R. B. Mitchell. STUDENTS' SECTION.—Friday, November 16, at 7.30 p.m., at the Royal Technical College, Glasgow. Address by the Chairman, Mr. J. F. Nielson.

THE ILLUMINATING ENGINEERING SOCIETY.—Tuesday, November 13, at 8 p.m., at the Royal Society of Arts, John-street, Adelphi, London, when Reports on "Progress During the Vacation" and "Developments in Lamps and Lighting Appliances" will be presented, and some interesting new types of lighting fittings, motor car headlights, &c., will be exhibited.

THE INSTITUTE OF MARINE ENGINEERS, INCORPORATED.—Tuesday, November 13, at 6.30 p.m. Adjourned discussion on the paper by Messrs. H. J. Young, F.I.C., and E. Wood, B.Sc., read at the Shipping and Engineering Exhibition on "A Note upon Cast-Iron for Marine Engine Castings from the Metallurgical and Engineering Points of View." The members of the Institute of British Foundrymen are specially invited to attend.

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.—Tuesday, November 13, at the Royal Society of Arts, John-street, Adelphi, the following paper will be read: "Galician-Canadian Pole Tool Fishing Methods," by Mr. Albert Millar, A.M.I.Mech.E., M.Inst.P.T.

THE SOCIETY OF TECHNICAL ENGINEERS; MANCHESTER DISTRICT.—Wednesday, November 14, at 7.30 p.m., in the Milton Hall, Deansgate, Manchester. Discussion on "The Function of the Staff Council in Industry."

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—Wednesday, November 14, at 6.30 p.m., at the Institution of Mechanical Engineers, Storey's Gate, St. James' Park, S.W. 1. "The Misuse of the Internal-Combustion Engine and Suggestions for its More Efficient Application," by Mr. L. Murphy.

THE ROYAL SOCIETY OF ARTS.—Wednesday, November 14, at 8 p.m., at John-street, Adelphi. Ordinary Meeting. "Téléphotographie, Télautographie, Télévision" (Avec Expériences et Projections). Par Monsieur Edouard Belin. The lecture will be delivered in French.

THE INSTITUTION OF CHEMICAL ENGINEERS.—Wednesday, November 14, at 7.30 p.m., at the Engineers' Club, Coventry-street, W. 1. (1) "A Study of the Conditions of Constant Rate of Flow in Filter Presses," by Messrs. M. B. Donald and R. D. Hunneman; (2) "A Study of the Absorption Tower," by Messrs. M. B. Donald and C. W. Tyson.

THE CHEMICAL ENGINEERING GROUP OF THE SOCIETY OF CHEMICAL INDUSTRY.—Friday, November 16, at 8 p.m., at the Chemical Industry Club, 2, Whitehall-court, London, when Professor J. W. Hinchley will read a paper entitled "A New Source of Potash and its Industrial Exploitation."

THE INSTITUTE OF METALS; SWANSEA LOCAL SECTION.—Friday, November 16, at 7.15 p.m., in the Metallurgical Department, University College, Singleton Park. Paper on "The Density of Alloys," by Professor Thomas Turner, M.Sc., A.R.S.M., F.I.C.

THE WEST BROMWICH ENGINEERING SOCIETY.—Friday, November 16, at 7.30 p.m., at the Technical School. Paper, "The Application of Science to Industry," by Dr. C. M. Walter, A.M.I.E.E., of the City of Birmingham Industrial Research Laboratories.

THE NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Friday, November 16. Paper on "Essential Factors of Ship Propeller Design," by Mr. A. F. Ainslie.

THE INSTITUTION OF MECHANICAL ENGINEERS.—Friday, November 16, at 6 p.m., at the Institution. Paper on "The Possibilities of Mercury as a Working Substance for Binary Fluid Turbines," by Mr. William J. Kearton, M.Eng.

THE INSTITUTION OF PRODUCTION ENGINEERS.—Wednesday, November 21, at 7.30 p.m., at the Engineers' Club, Coventry-street, W.1, "The Use of Charts in Engineering," by Mr. A. W. Swan, B.A.Sc.

THE DURABILITY OF REFRACTORIES.—A paper on the durability of refractories was read on the 1st inst. by Mr. W. J. Rees, before the Birmingham Metallurgical Society. It dealt with the British resources in refractory materials, their utilisation to the best purpose, the factors which determined the durability of refractories in furnace construction, and emphasised the desirability of close co-operation between the maker and the user of refractories.

CANADIAN RAILWAY EXTENSION.—H.M. Trade Commissioner at Toronto reports that the Ontario Government has called for a survey to be made of the cost of extending the Temiskaming and Northern Ontario Railway, which is owned and operated by the Government, so as to serve the Lorraine mineral producing area. The Commissioner of the railway has been instructed to make a thorough investigation of the engineering features and cost of such a project, and to report the result to the Premier.

BELGIAN IRON AND STEEL CONTRACTS.—The journal for October, No. 6, issued by the British Chamber of Commerce in Belgium, draws the attention of British buyers to the conditions of sale which are followed by Continental iron and steel manufacturers. They state that the goods are delivered, taken and accepted on wagon at the despatching station; the goods travel at the risk and peril of the consignee; the purchaser has to procure the wagons necessary for the transport, &c., all of which complicate business transactions with Continental firms.

LONDON UNDERGROUND RAILWAY EXTENSIONS.—In view of the fact that the new extension line of the Hampstead and Highgate Tube from Golders Green to Edgware will be opened on the 19th inst., as far as Hendon Central, the company have prepared and are exhibiting a cinematograph film illustrating the construction of the line, and also showing the work of tunnel enlargement now proceeding on the City and South London line. The film, which is being shown in various public places by means of a portable daylight projection apparatus, illustrates the work in a manner calculated to interest the general public, but we understand that it is actually a part of a more complete film made to serve as a technical record. Though obviously a difficult subject for cinematography, many interesting details of the tunnel enlargement work are clearly shown in the film, which also illustrates the erection of a plate girder bridge spanning Finchley-road at Golders Green, in spite of the fact that this operation was carried out at night. The film has been produced for the company by the Scientific and Industrial Film Association, Gloucester House, Charing Cross-road, W.C. 2, who specialise in this class of cinematography.

THE BARBER-GREENE VERTICAL BOOM TRENCH DIGGER.—In the description of the new trench digger given on page 396 of our issue of September 28, we mentioned that a shearing pin was inserted in the sprocket drive of the excavating bracket chain, in order to secure the machine against serious damage in the event of the buckets meeting an immovable obstruction. We have since been informed that an improvement has been made by the manufacturers, in this connection. The safety pin device, which if it broke required about 5 minutes' work to put in order again, has been replaced by a mechanical overload release arrangement incorporated in the sprocket. This overload release simply allows the sprocket to slip, if too much strain is put upon the machine in digging, and picks up again automatically after the strain has been removed. It is often possible, when the chain has stalled against an obstruction, for the operator to clear it, by stopping it and then working at low speed and effectively breaking up the material. A device of this kind will naturally add considerably to the ease and rapidity of working. As previously mentioned, the representatives in this country for the Barber-Greene Company are the Alliance Machinery Company, Limited, 70, Victoria-street, S.W. 1.

LAUNCHING A NEW BOW FOR THE SALVED STEAMSHIP "SYDLAND."

(*For Description, see Page* 580.)

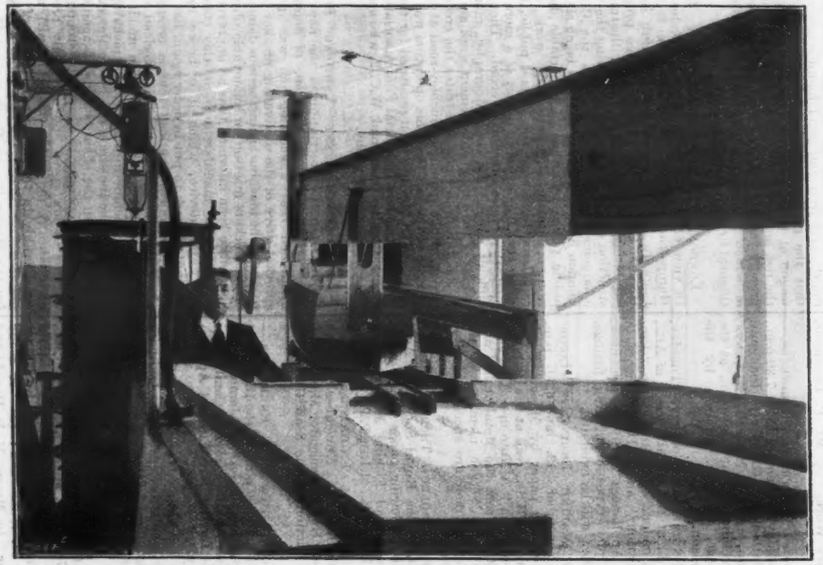


FIG. 8. MODEL OF SHIP'S BOW, SLIPWAY AND BASIN.

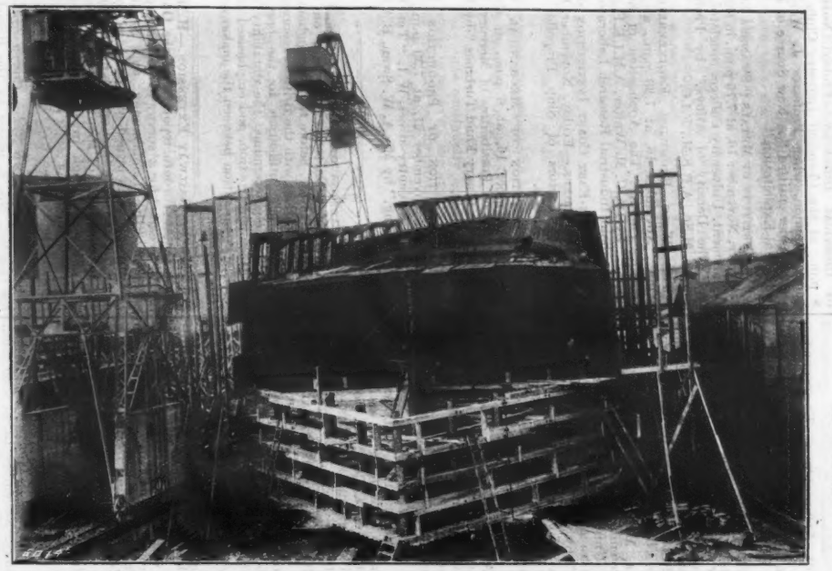


FIG. 10. BUILDING THE FRAME FOR THE LAUNCHING OF THE BOW.

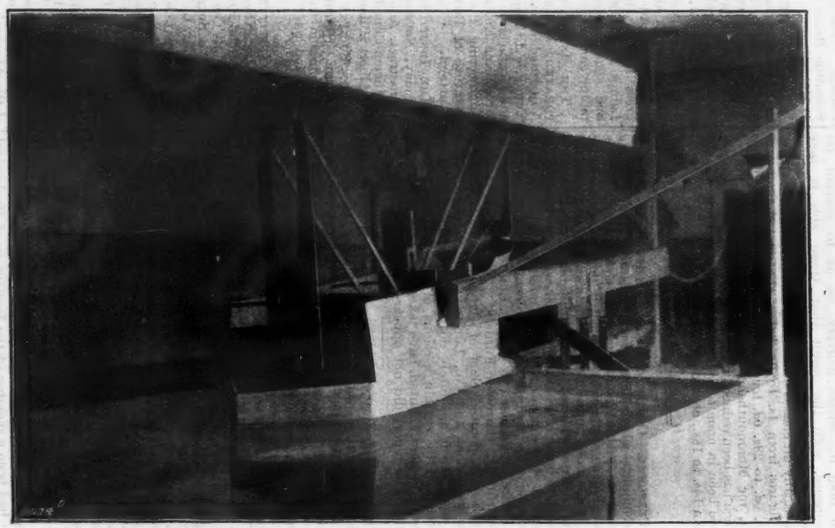


FIG. 9. LAUNCHING TESTS WITH MODEL.

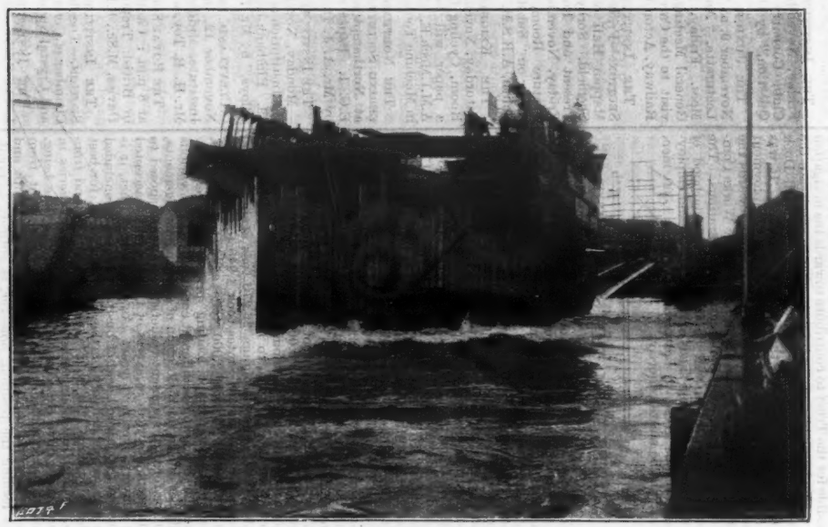


FIG. 11. THE NEW BOW TAKING THE WATER.

7-H.P. AUSTIN MOTOR CAR AT THE OLYMPIA EXHIBITION.

CONSTRUCTED BY THE AUSTIN MOTOR COMPANY, LIMITED, LONGBRIDGE, NEAR BIRMINGHAM.

(*For Description, see Page* 584.)

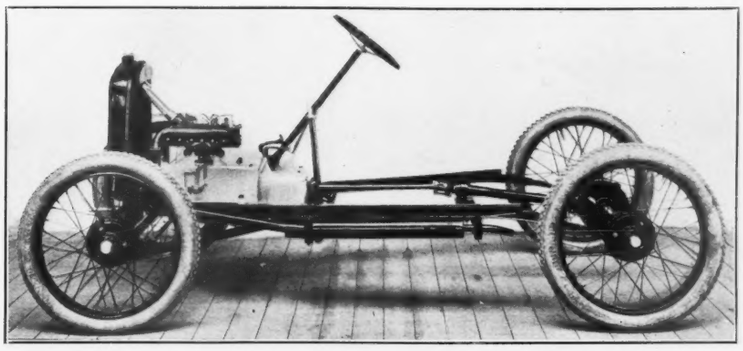


Fig. 1.

Fig. 2.

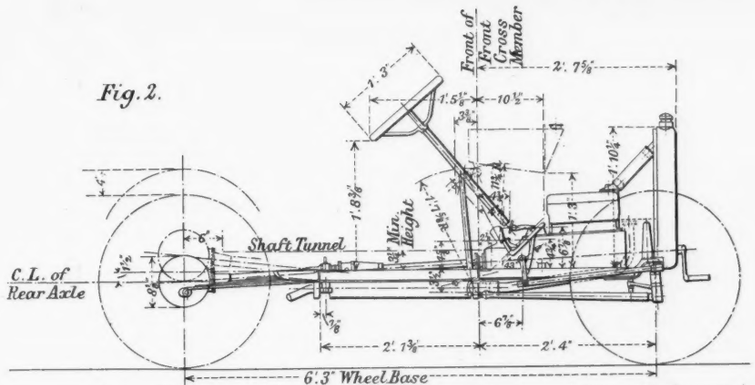


Fig. 3.

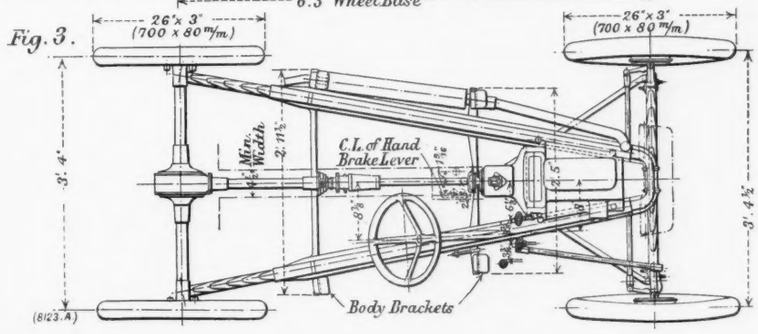


Fig. 4.

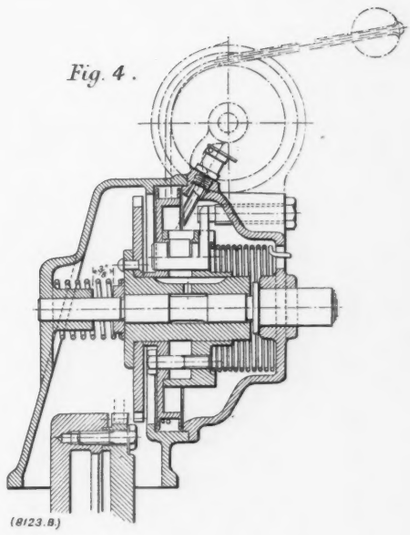


Fig. 5.

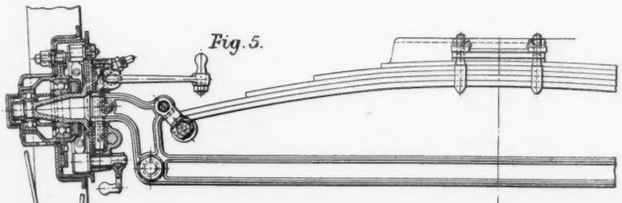


Fig. 6.

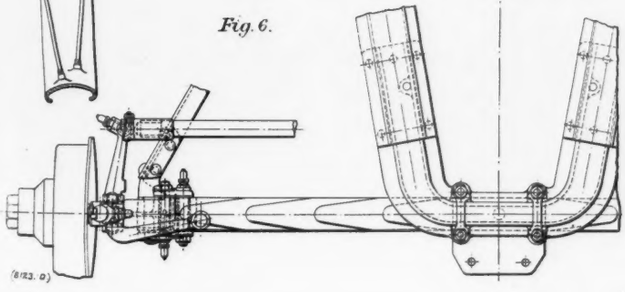


Fig. 7.

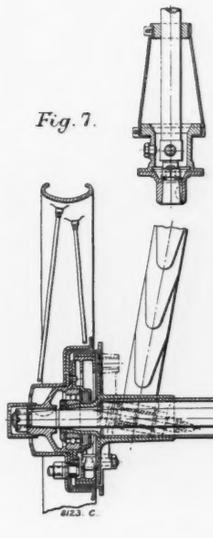
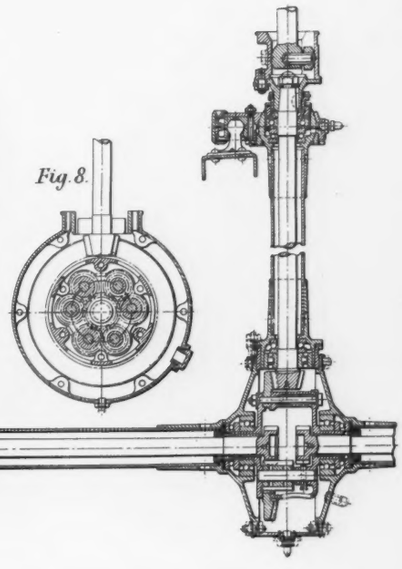


Fig. 8.



(*To face page* 584.)

20-H.P. RUSTON-HORNSBY MOTOR

CONSTRUCTED BY MESSRS. RUSTON

(For Desc Page 5

Fig. 9.

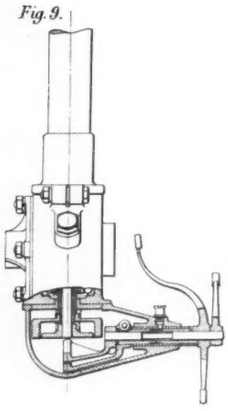


Fig. 10.

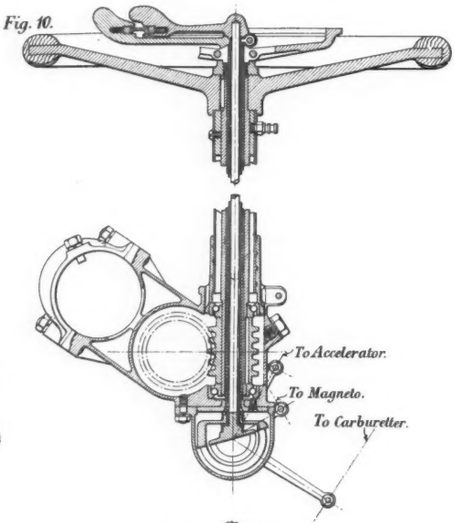


Fig. 11.

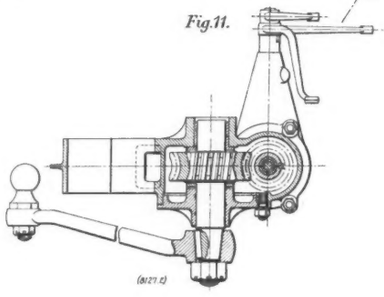


Fig. 12.

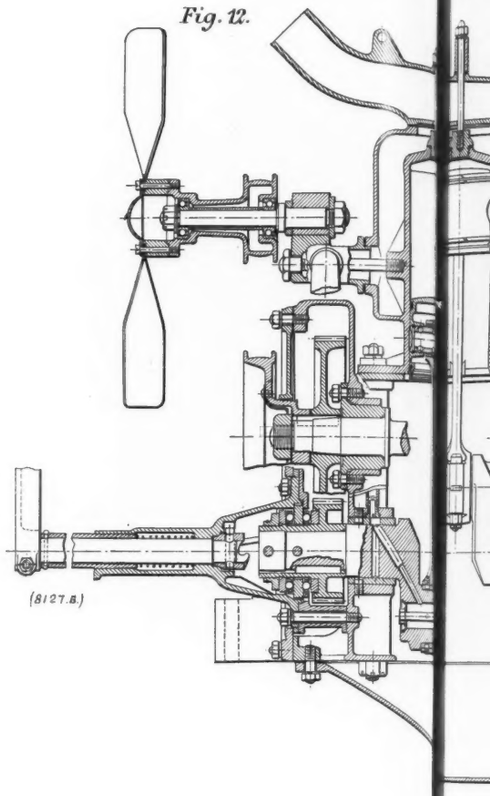


Fig. 14. SECTION ON A.A.

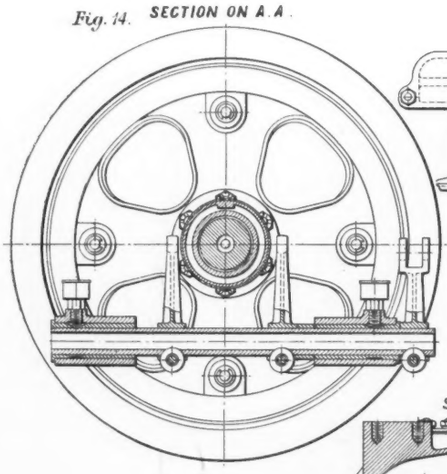


Fig. 15.

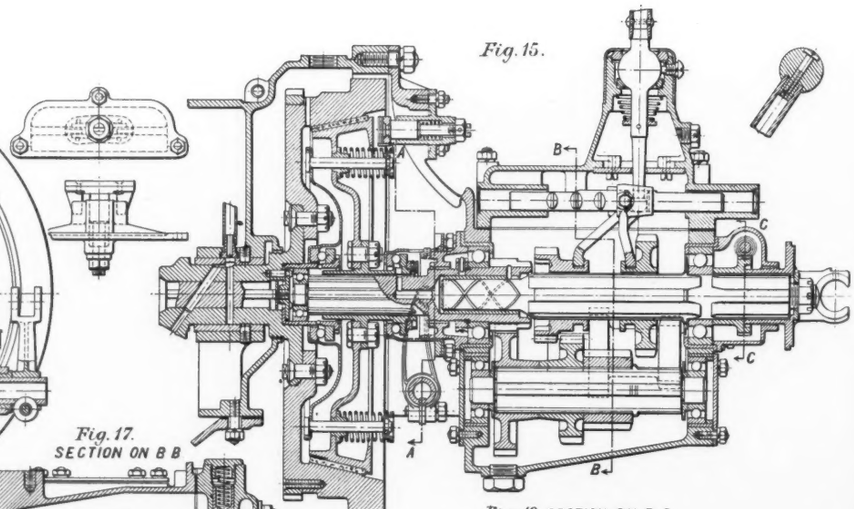


Fig. 16. SEC. ON C.C.

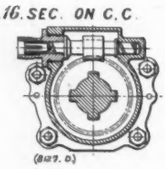


Fig. 17. SECTION ON B B

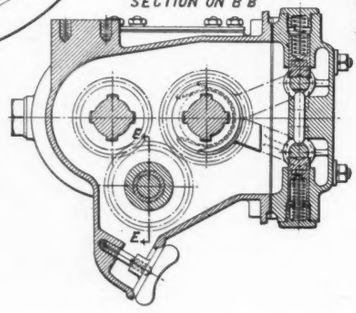
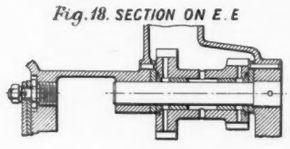


Fig. 18. SECTION ON E.E



TOR AT THE OLYMPIA EXHIBITION.

RUSTON [illegible]NSBY, LIMITED. ENGINEERS, LINCOLN.

(*For Desc[illegible]* Page 584.)

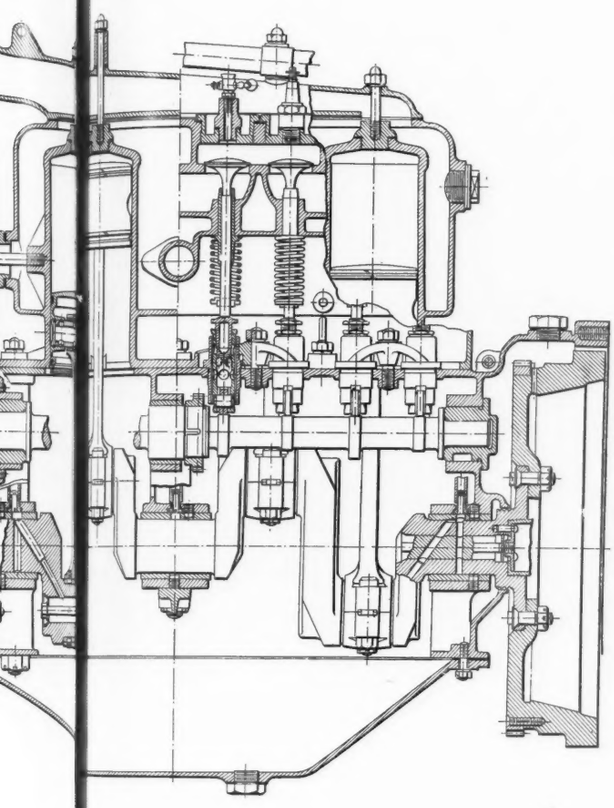
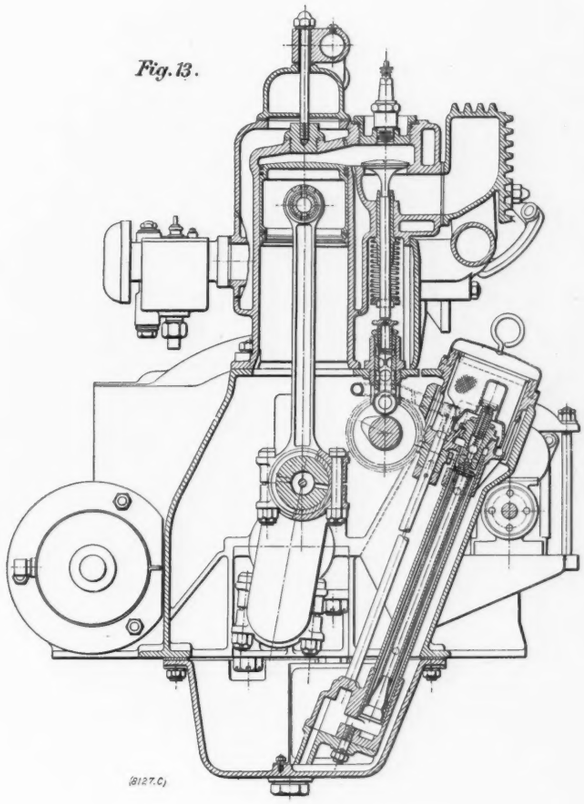
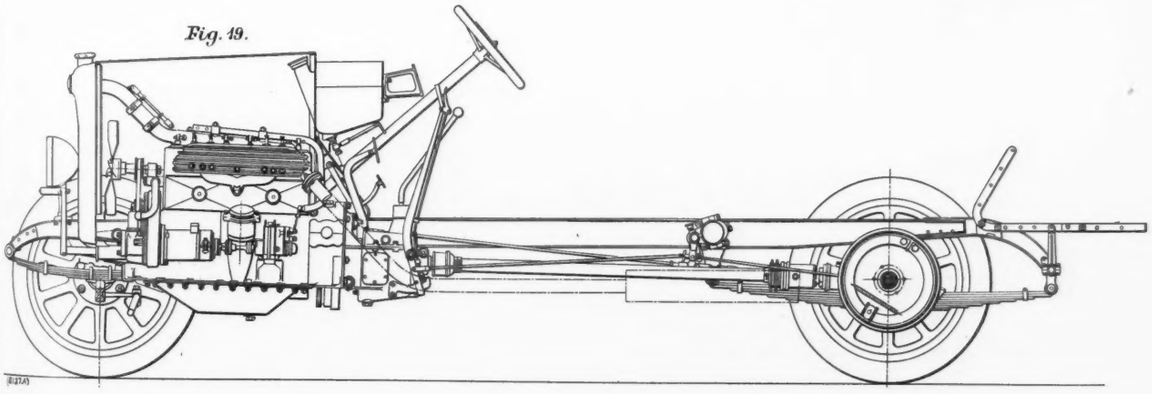


Fig. 13.



(B127.C)

Fig. 19.



(B127.A)

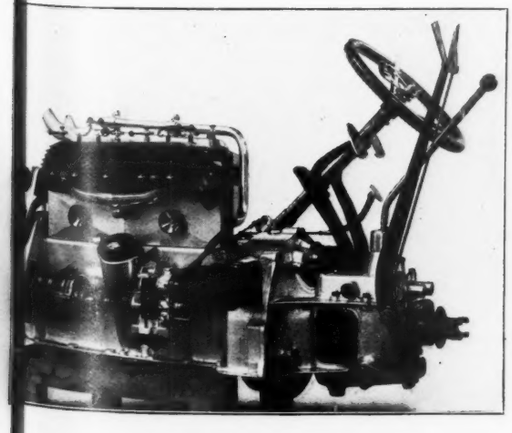


FIG. 20.

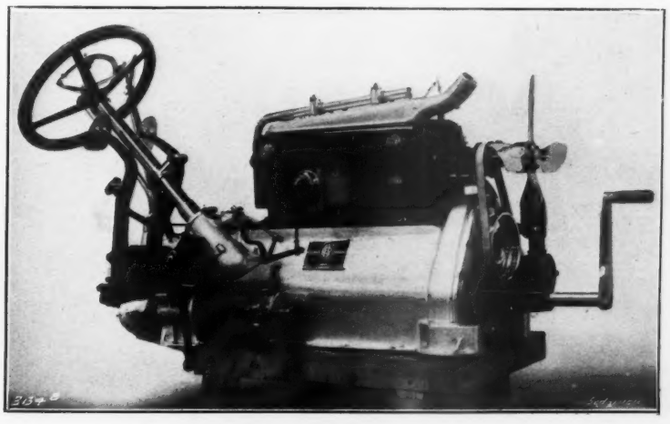


FIG. 21

23-60-H.P. VAUXHALL MOTOR CAR ENGINE AT THE OLYMPIA EXHIBITION.

CONSTRUCTED BY VAUXHALL MOTORS, LIMITED, LUTON.

(*For Description, see Page* 584.)

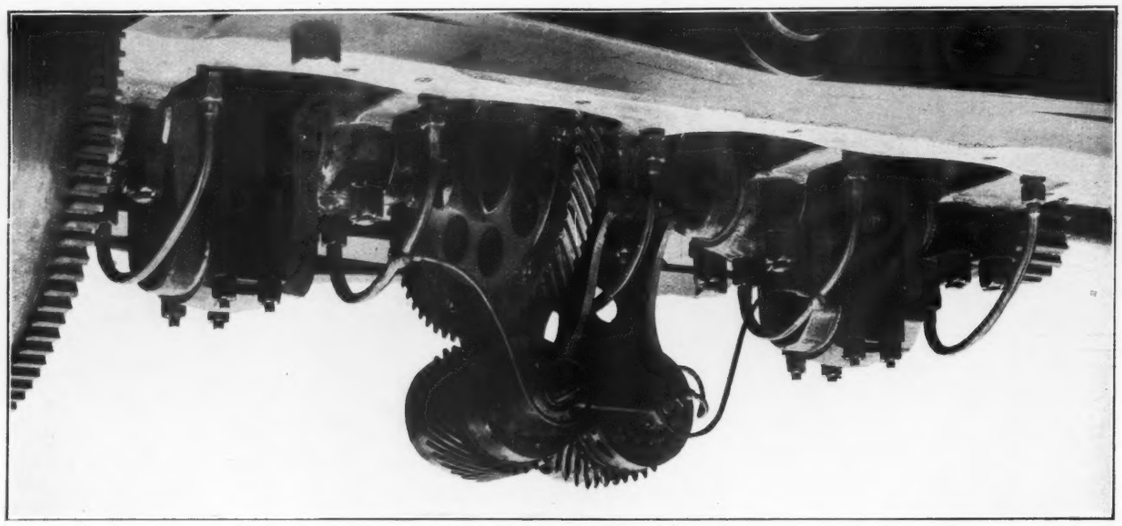


FIG. 22.

Fig. 23.

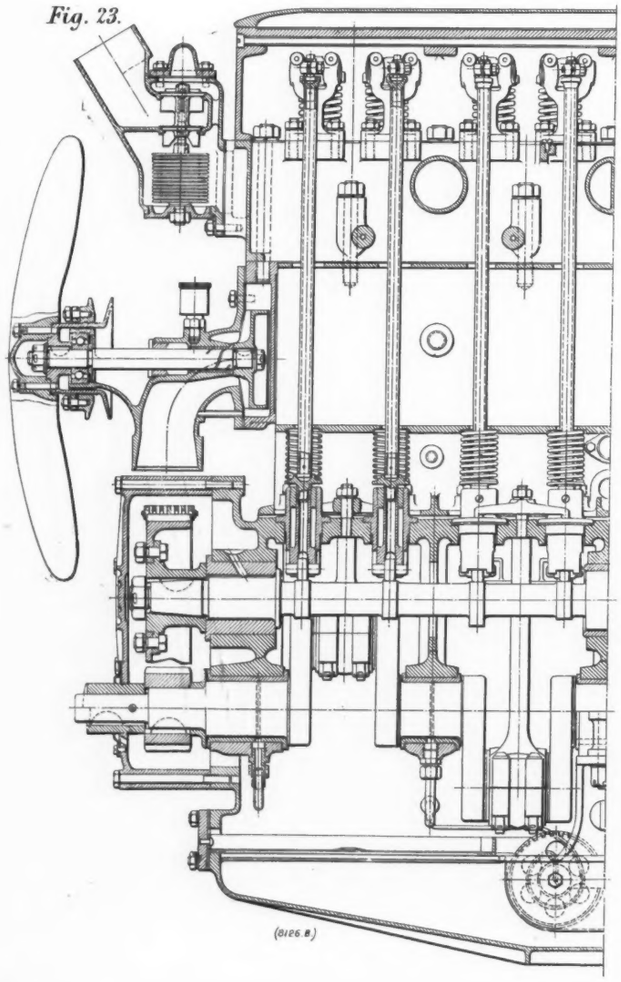
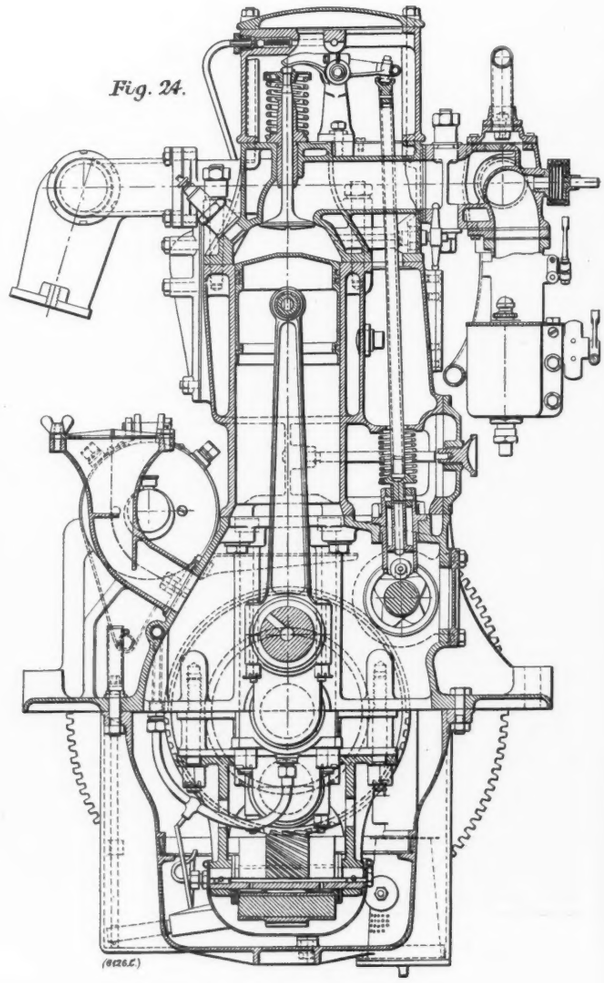


Fig. 24.



(*To face page* 585.)

ENGINEERING.

Offices for Publication and Advertisements, 35 and 36, Bedford Street, Strand, London, W.C.2.

We desire to call the attention of our readers to the fact that the above is our SOLE ADDRESS, and that no connection exists between this Journal and any other publications bearing somewhat similar titles.

TELEGRAPHIC ADDRESS } "ENGINEERING," WESTRAND, LONDON.

TELEPHONE NUMBERS—3663 and 8598 GERRARD.

SUBSCRIPTIONS, HOME AND FOREIGN.

"ENGINEERING" may be ordered from any newsagent in town and country and at railway bookstalls, or it can be supplied by the Publisher, post free, at the following rates, for twelve months, payable in advance :—

For the United Kingdom	—	—	£3 5 0
For Canada—			
Thin paper copies	—	—	£2 18 6
Thick paper copies	—	—	£3 3 0
For all other places abroad—			
Thin paper copies	—	—	£3 3 0
Thick paper copies	—	—	£3 7 6

Foreign and Colonial subscribers receiving incomplete copies through newsagents are requested to communicate the fact to the Publisher, together with the agent's name and address.

When foreign subscriptions are sent by Post Office Orders, advice should be sent to the Publisher.

ADVERTISEMENT RATES.

The charge for advertisements classified under the Headings of Appointments Open, Situations Wanted, Tenders, &c., is four shillings for the first four lines or under, and one shilling per line up to one inch. The line averages seven words. When an advertisement measures an inch or more the charge is 12*s.* per inch. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

TIME FOR RECEIPT OF ADVERTISEMENTS.

Advertisements intended for insertion in the current week's issue must be delivered not later than First Post on Thursday. In consequence of the necessity of going to press early with a portion of the edition, alterations for standing advertisements should be received on the Friday previous to the day of publication.

All accounts are payable to ENGINEERING, LTD. Cheques should be crossed "The National Provincial and Union Bank of England, Limited, Charing Cross Branch." Post-Office Orders should be made payable at Bedford-street, Strand, W.C. 2.

AGENTS FOR "ENGINEERING."

AUSTRALIA: Gordon and Gotch, Limited, Melbourne; Sydney; Brisbane; Perth. Angus and Robertson, Limited, Sydney, N.S.W. T. Willimett and Co., Townsville, North Queensland. W. C. Rigby, Adelaide, South Australia. Melville and Mullen, Melbourne, Victoria.

BELGIUM, Brussels: E. F. Satchell, 86, Rue du Tabellion.

CANADA, Toronto, Ont.: Wm. Dawson and Sons, Limited, 87, Queen Street, East.

EDINBURGH: John Menzies and Co., Limited, Rose-street.

FRANCE, Paris: Boyveau and Chevillet, 22, Rue de la Banque. For Advertisements, Office de Publications Commerciales, 167 Rue Montmartre, Paris (2e).

GERMANY: Hermann H. Fromm, Potsdamerstr 105A, Berlin, W. 35. A. Twietmeyer, Leipzig.

GLASGOW: William Love, 221, Argyle-street. John Menzies and Co., Limited, West Nile-street.

INDIA, Calcutta: Thacker, Spink and Co. Bombay: Thacker and Co., Limited.

ITALY: U. Hoepli, Milan. Anonima Libraria Italiana, Torino. And any post office.

LIVERPOOL: Mrs. Taylor, Landing Stages.

MANCHESTER: John Heywood, 143, Deansgate.

NEW ZEALAND: Gordon and Gotch Proprietary, Limited, Wellington, Auckland and Christchurch.

NORWAY, Christiania: Cammermeyer's Boghandel, Carl Johans Gade, 41 and 43.

ROTTERDAM: H. A. Kramers and Son, Limited.

SOUTH AFRICA: Central News Agency, Limited, Head Office—Johannesburg; and Pretoria, Cape Town, Port Elizabeth, Bloemfontein, Durban, and various branches and bookstalls throughout South Africa. Wm. Dawson and Sons (South Africa), Limited, 29, Long-street, Capetown.

TASMANIA: Gordon & Gotch Prop'ty, Ltd., Launceston: Hobart.

UNITED STATES: For Subscriptions, New York: W. H. Wiley, 432, Fourth Avenue. For Advertisements: J. S. Allan, 30 Church-street, New York.

CONTENTS.

	PAGE
Literature	579
Books Received	580
Launching a New Bow for a Salved Steamship (*Illus.*)	580
The Scientific and Industrial Research Department, 1922–3	582
The Motor Exhibition at Olympia (*Illus.*)	584
The Brewers' Exhibition	590
The "Coventry" Chain Drive (*Illus.*)	590
Air-Break Gate-End Circuit Breaker (*Illus.*)	591
Industrial Notes	591
Letters to the Editor.—"The Michell Crankless Motor." "A Method of Improving the Wave-shape of Alternators."	592
Notes from South Yorkshire	592
Notes from Cleveland and the Northern Counties	592
Notes from the North	593
Notes from the South-West	593
Notices of Meetings	593
The Young Engineer and the Future	595
The Right of Trade Unionists to Inspect the Books of their Union	596
Exhibitions	596
X-Rays and Atoms	597
The Late Dr. John Edward Stead (*With Portrait*)	598
Improvements in Aircraft Compasses	600
Safety of Life at Sea	600
Notes	601
Reinforced Concrete Overbridge at Wembley Hill Station (*Illus.*)	602
The Institution of Civil Engineers	603
Development of Ships' Structural Design (*Illus.*)	605
Catalogues	608

One Two-Page Plate and Two One-Page Plates.—*THE MOTOR EXHIBITION AT OLYMPIA.*

ENGINEERING.

FRIDAY, NOVEMBER 9, 1923.

THE YOUNG ENGINEER AND THE FUTURE.

ALTHOUGH any period of bad trade must to some extent affect every industry in a country, such periods in the past have generally shown a certain amount of selecting power and have borne more hardly on some than on others. In the present widespread depression probably no trade or profession has escaped lightly, but even now some industries have fared worse than others. Engineering is probably one of these. For our present purpose it is not necessary to enquire very closely into the reason for this, but an obvious partial explanation lies in the fact that the war-time activity of industry was largely an engineering activity, so that the armistice found us with enormous stocks of engineering material which had to be absorbed before normal conditions could supervene. To this difficulty, peculiar to the trade, was added the general difficulty following the collapse of markets all over the world. This fell with especial severity on an industry which is so largely concerned in providing the tools for others. The stagnation of shipbuilding and marine engineering are to be largely explained by this factor, added to special conditions which are generally understood. The final effect over the whole field of engineering is a condition of low production which has reacted very unfavourably on young engineers who are beginning—or are attempting to begin—their professional careers.

In his presidential address delivered to the Institution of Civil Engineers last Tuesday, Sir Charles L. Morgan had something to say on this question. In view of the nature of the professional work in which Sir Charles has spent his life he naturally dealt in the main with transport and transport questions. His thesis was that the young engineer of to-day, in spite of difficult times, need not fear the future, and he suggested engineering possibilities and promise not only equalling, but far surpassing, the achievements of the past. To illustrate his point Sir Charles dealt in some detail with the question of the internal transport of London, tracing it from its early days to the organised complexity of the present, and pointing out that the problem was, if anything, growing more quickly than were the facilities for dealing with it. As his address is reproduced elsewhere in our columns this week we need not here attempt to follow Sir Charles in the details of his argument, but there is no question at all about the soundness of his conclusions. So far from the engineer having done with the question of London transport, there is every evidence that as much—or more—in the way of invention and material equipment will be required from him in the next fifty years as he has contributed in the last half century.

As with London transport, so with practically every material aspect of civilised life. Engineering is every day extending its sphere, and every type of activity is continually enlarging its tribute to its practitioners and their methods. There is a vista before the young engineer the end of which no man can see. This is, perhaps, a vague phrase and the young engineer who, as Sir Charles Morgan put it, is "confronted by extraordinary difficulty in obtaining work" may not be very edified by it. That, however, does not affect the truth of the position. Sir Charles was mainly addressing the young civil engineer, and suggested that some of them might "believe that the profession of civil engineering has entered upon a permanent decline." This is manifestly not the case, and even in the single field of transport in which civil engineering holds a very important position, as Sir Charles showed, there is more civil work for the engineers of the future than has been done by their seniors in the past. The young engineer out of a job is, however, naturally more interested in the present than in any other time, and those with a civil engineering training cannot but be interested in the many large works which are now being pushed forward. They are certainly being undertaken mainly in the interests of unemployed labour, and little attention is being paid to the claims of unemployed civil engineers, but many junior staff men must necessarily benefit as a result of these works.

The broad general question of placing in appointments the large number of youths who are being trained, in one way or another, for an engineering career is but little touched, however, by any such matters as development works undertaken to help the general body of unemployed labour. The prospects of the young unemployed engineer are bound up with the prospects of the country. He would be wise to expect no preference as he will certainly get none. It is very possible that we are training too many men for staff engineering posts, as, so we are told, we are training too many other men to be doctors, teachers and what not, but the sphere of engineering is increasing in extent at such an enormous rate that it is difficult to believe that the right type of youth will not ultimately find his feet in it.

The whole question of what to do with our boys is a very old one, but in a period like the present it assumes a new difficulty. That difficulty will not be solved until the prosperity of the country is restored, but in some ways engineers may feel that they are specially ill-treated by conditions like those they are now presented with. A large number of railway and other works are to be carried out primarily with the idea of absorbing some of the unemployed labour, but it is tacitly and correctly assumed that a large proportion of these works are in themselves perfectly sound commercial speculations and will pay their way. That is to say that the engineer *per se* could at any time during recent years have carried out these works to the general benefit, but was prevented until they were undertaken on a semi-philanthropic basis. The engineer no more than anyone else can expect to escape from the consequences of financial considerations, but it is especially hard that he should be prevented from doing work which would not only be to his own benefit and to the benefit of the juniors who are following him, but would without question pay its way and act for the general good of the country.

Engineers have done much in the past and have changed the whole material basis of civilised life, but they have none the less been prevented from doing all that they might have done. Sir Charles

Morgan in his address referred to the promotion of new railway schemes in 1870 and the activity in the committee rooms of the House of Parliament. The type of work which this activity represented, however, was of no real value to the country, and merely added unnecessary expense to what was mainly a piece of engineering work. Ultimately valueless expenditure of this kind is by no means confined to railways, and one of our large electric power companies, for instance, has a sum of 81,000*l.* standing in its books and representing the cost of obtaining its special Act. This kind of thing is a mere tax on engineering development, and the less of it there is in the future the more engineering work there will be to do, and as a consequence the more possibilities there will be of the juniors in the profession obtaining a fair start in life.

THE RIGHT OF TRADE UNIONISTS TO INSPECT THE BOOKS OF THEIR UNIONS.

The judgment of the Court of Appeal, on October 31, 1923, in the case of Dodd *v.* The Amalgamated Marine Workers Union, settles a question of considerable importance to trade unionists generally, viz., whether a member of a trade union is entitled to inspect the books of the union by means of a professional accountant. A trade union cannot be registered under the Trade Union Acts unless its rules provide that its books may be inspected by every person having an interest in the funds of the union.

Mr. Alfred Dodd, a member of the Amalgamated Marine Workers Union, who has had a good deal of litigation against the union, applied some time ago to the officials for an opportunity of inspecting the books of the union, and stated that he would bring with him, to inspect them, a Mr. Smedley, a chartered accountant, who was not a member of the union. The rules of the union provide that any member or person having an interest in the funds is entitled to inspect the books. When the plaintiff, Mr. Dodd, along with his accountant, attended at the offices of the union the secretary refused to allow the accountant to see the books, although he offered to give a written undertaking not to divulge any information except to the plaintiff. The plaintiff then brought an action in which he claimed a declaration that he was entitled to have the books inspected by an accountant. He relied on a case, Bevan *v.* Webb, in 1901, in which the Court of Appeal decided that a partner of a firm had a right to examine the partnership documents by means of a professional accountant, and a later case in 1909, Norey *v.* Keep, in which Mr. Justice Parker decided that a member of a trade union was entitled to have the books of the union inspected by an accountant on his behalf provided the accountant gave an undertaking not to make use of the information which he acquired except for the purpose of advising his client. In the present case the union maintained that the plaintiff was quite able to inspect the books himself; that his object in attempting to have them inspected by an accountant was not in *bona fide*, and that the action was really instigated by a rival union. Mr. Justice Astbury came to the conclusion that the plaintiff was not acting in the interest of the other union, but was acting in what he conceived to be the interest of the union of which he was a member, and, following Mr. Justice Parker's judgment in the earlier case, His Lordship decided in favour of the plaintiff.

The union appealed, but the Court of Appeal confirmed the law as laid down in the earlier cases, and held that the plaintiff was entitled to have the books inspected by his accountant. The Master of the Rolls, following the judgments in the earlier cases, took the view that when a statute or a contract of partnership or the rules of a trade union provide that a person is to have the right to inspect the books of the partnership or of the union this means that he is to have the right to make an effective inspection; and that, if he thinks fit, he may employ a person of skill, such as an accountant, to examine them on his behalf.

The law was admirably stated in Norey's case, by Mr. Justice Parker, who said that in considering whether the right of inspection was merely a personal right or a right which might be exercised by means of an agent it was important in each case to consider with what object the right of inspection was conferred. As regards trade unions the object was to enable those who thought that matters had in any way gone wrong to inspect the books to see whether that was so or not. The members of trade unions were not usually so trained as to be able to make a satisfactory investigation of books of account, and it was manifest that their rights would be almost, it not entirely, defeated if they had to make the investigation by personal inspection. Large sums were received by these societies, and they made numerous small payments and had probably voluminous books of accounts, and an untrained person could not make a proper investigation without the assistance of a trained accountant.

In the present case the union contended that they had a right to refuse to show the books to an accountant if they had reasonable grounds for doing so, but the Master of the Rolls, after pointing out that Mr. Justice Astbury had held that the plaintiff was acting in *bona fide*, said that there was nothing in the Act to show that the union had a discretion to refuse inspection merely because they had a suspicion that the plaintiff was not acting properly.

The cases in which members of a trade union may wish to have the books examined by an accountant may not be numerous; but in these days when there is so much controversy as to the expenditure of trade union funds on political objects, it is satisfactory, in the best interests of the unions and their members, that it has been authoritatively decided that a member of a registered trade union desiring to have the union's books examined is entitled to employ a professional accountant to make the examination for him.

EXHIBITIONS.

For his presidential address before the Royal Society of Arts on Wednesday last, Lord Askwith very appropriately took the subject of Exhibitions. We say appropriately because the society itself may be considered to have been the first body to extend the scope of exhibitions beyond the range of the so-called fine arts, and to have suggested their value from an industrial point of view. Appropriate again the subject was, because Lord Askwith himself has been closely connected with the official side of exhibition work, and was a member of a representative international body which considered, before the war, the possibility of regulating and systematising the larger enterprises which are now and then attempted.

To the ordinary public a great exhibition so far as this country is concerned has something of a mystery about it. No one seems to know who is really behind it, though the name of the manager or organiser, if sufficiently well manipulated, may become familiar. Before the war, as Lord Askwith pointed out, exhibitions degenerated practically into a small special section which imparted a name to a collection of side shows. Who decided upon the country to be represented, and what system was there in the schemes? There was little or nothing to prevent anyone coming forward with a view to promote an exhibition, with the result that in the end they carried little or no weight and people attended them for the sake of the amusements only. Neither has system prevailed with regard to enterprises of an international character, though Lord Askwith reminds us that a near approach to this was attained before the war, but the recommendations then made were unfortunately not ratified by the fifteen Powers whose representatives drew them up in conference.

The international exhibition is a complicated proposition. It may, and probably does, stimulate trade with a country making a good and thoroughly representative show. On the other hand, the fear that it will give foreign and other rivals the opportunity to study a firm's or a country's products, so as later to enter into competition with them, still carries weight. This end, however, can so easily be attained in these days in other ways, if people have no scruples in the matter, that the objection is largely discounted, while abstention from an important exhibition may mean a serious loss of business, to the benefit of other countries. The ideal would be for exhibitions on the international scale to be regulated by friendly agreement between the nations, so that they may be held at suitable intervals and under uniform regulations. It would then be possible to arrange for representative displays in a less haphazard manner than at present, and manufacturers would know how to form their plans.

The manufacturer is often handicapped by lack of knowledge. He may wish to be represented at an important show at home; at the same time he is invited to support an exhibition abroad. The firm's resources may not enable it to indulge in the expense of exhibiting often, and a decision has to be come to as to which direction should be taken. In this connection we are rather surprised that Lord Askwith makes no mention of two forms of exhibition which appear to be growing in importance as regards definite business results.

We refer to the British Industries Fairs, and the sectional exhibitions of which we constantly have experience in London, &c. The opportunity of securing orders abroad by exhibiting in a foreign country are on the whole now fairly well appreciated, though the British sections have not usually won great praise for good arrangement or organisation. Perhaps we could improve upon this if some definite official policy towards such enterprises were adopted. The sectional exhibitions are usually not official, in the sense that they are independent of Government organisation. Their control usually rests with some body representative of the trade in question, and as a rule the impression seems to be that these shows when well done, and not too frequent, are decidedly helpful in a business way. The Machine Tool Exhibition may be taken as an instance. This exhibition is always attractive to the general public, but it is far more so to persons directly interested, and is attended by a good many foreign visitors, who can best become acquainted in this way with the large range of British products. The result is that exhibitors usually feel rewarded for the trouble they have taken, and their order books benefit at the time or may be later. We have only cited one instance—many might be given of the successful endeavour to attract just the people interested in some particular thing. The motor car, commercial vehicle, and cycle and the road transport exhibitions are similar efforts in which the public is not refused admittance, but the attendance of those specially interested is particularly sought, and as a rule with some success. In these shows there is no attempt to attract by means of amusements.

In the case of the British Industries Fairs official assistance is forthcoming in organisation and other ways, and the attempt is purposely made to attract foreigners with the idea of stimulating trade abroad. In one direction these fairs have always appeared to us to be disappointing. It is admittedly difficult to display at them representative lines of heavy engineering, but the number of foreign visitors attending them is so great that it is to be deplored that no serious attempt is made to acquaint them with the wide capabilities of our big firms. Heavy engineering is as much one of the staple trades of the country as the manufacture of small articles, and the fairs cannot be truly representative, or run in the general interests, so long as this industry has no part in them. The fairs are, we take it, intended to be a kind of information bureau at which a foreign or other buyer can get information which will put him on the track of what he wants, if we produce it in this country. At present this is hardly possible for him as regards, for instance, machine tools, which are not shown. The fairs should not, in our opinion, be considered as rivals of the sectional exhibitions previously referred to, and we believe it would encourage foreign business if our machine tool makers exhibited at them, even if only to the extent of a small combined stand for a whole association. It would attract attention and might bring business. No embargo should prevent these fairs from being representative in every sense, whatever policy may be adopted towards other exhibitions organised by independent and sometimes self-appointed exploiters.

Lord Askwith naturally turned much of his attention to the forthcoming British Empire Exhibition. This, of course, stands in a category by itself. It is not international, and it is not sectional. It

is the first comprehensive attempt to bring into small focus all the possibilities of the resources of our widely distributed lands and peoples. At previous exhibitions individual colonies have created a good deal of interest. For the first time our great Dominions will share in an effort intended to result in the branches of the Empire becoming better acquainted. It should improve our intercourse and draw more closely the ties binding us together, which all so splendidly showed that they acknowledged in the late war. The old catch phrase "Support Home Industry," needs to be widened to "Support the Empire." His Royal Highness the Prince of Wales, on Tuesday last, spoke on the advantage of first-hand knowledge of the Empire and advocated a spirit of travel for all distributors of knowledge. Nothing, it is true, can compare with travel, which can hardly fail to impress even the dullest mind with the wonders achieved by our race; but if travel, as His Royal Highness admits, is so expensive that few can indulge in it, the next best thing is to contrive something representative and instructive in our midst. It is this which we hope may be accomplished at Wembley next year. The exhibition should be invaluably instructive, a source of inexhaustible information as well to the people of this country as to the many who will, doubtless, come from the Overseas Dominions; while the foreigner who may attend should have an opportunity such as has never been presented before, of realising the correctness of our title to the position we hold in the world.

X-RAYS AND ATOMS.

At a meeting of the Röntgen Society, held on Tuesday evening last, in the Institution of Electrical Engineers, Sir Oliver Lodge, F.R.S., delivered his inaugural address as president of the society for the ensuing year.

He said that when a discovery of first rank was made, the ultimate consequences always exceeded anticipation. Radioactivity was a discovery of this kind, whether we had regard to the natural variety discovered by Becquerel or to the artificial type discovered by Röntgen a few months before. At the time no one could have expected that these radiations would give us a method of exploring the inmost secrets of atomic structure. Within three years of their discovery, however, J. J. Thomson and Townsend had used the X-rays to turn air into an electrolyte and had thus determined the value of the atomic charge, whilst later on, Moseley and others by the same means had investigated the electrical constitution of matter.

An electric charge e falling through a potential of V volts acquired a velocity given by the expression $e\,V = \frac{1}{2}\,m\,v^2$.

In this equation, the value of e was unknown, so also was m, but the value of v was determined by Rutherford, and knowing this the above equation gave the value of $\frac{e}{m}$, which might be called the electrochemical equivalent of the ion involved. This turned out to be more than 1,000 times as great as any known in ordinary electrolysis. Neither e nor m was, however, known. Soon after this determination of $\frac{e}{m}$, Zeeman measured the broadening of spectral lines when the source was exposed to a strong magnetic field, and by an analysis of his observations showed that the source of radiation had the same electrochemical equivalent. It thus appeared that it was the electron and not the atom which was responsible for radiation.

Ionising air by X-rays, J. J. Thomson measured its resistance. The current carried was equal to $n\,e\,v$, where n denoted the number of ions, e the charge, and v the velocity, and we had thus the equation $n\,e\,v = \frac{1}{R}$.

He next, in a most remarkable way, counted the number of particles acting as ions, making use of C. T. R. Wilson's discovery that these ions could act as condensation nuclei in dust-free supersaturated air. Each particle formed the nucleus of a minute globule of water. The total weight of the water in the cloud formed was determined, and finally the diameter of the globules, by observing the rate at which the cloud fell through still air. Knowing the total weight of the cloud and the diameter of the constituent droplets, the size of each could be calculated. When this was known everything was known, and the long-suspected electron was brought to the light of day, and the cathode rays shown to be electrons, or, as Crookes had surmised, matter in a fourth state.

At the outset, some thought that X-rays might also be particles, others, including at first Röntgen himself, thought they might be a longitudinal vibration of the ether analagous to a sound wave; whilst others again suggested that they might be pulses or very high-frequency vibrations of the ether, and this they had proved to be. X-rays were, in fact, ultra-ultra-violet light. Their straight-line passage through matter had already been provided for by Helmholtz's theory of dispersion, which showed that as we went further and further up the spectrum there came a time when the dispersion no longer increased the shorter the wave-length, but that as it were, the spectrum doubled back on itself, the dispersion became less and less until with infinitely short waves there would be no refraction at all. The X-rays were not of infinitely short wave-length, but this wave-length was short as compared with the size of the atom, and thus the X-rays were able to pass through without refraction. The speaker had himself tried to measure the wave-length of these rays by the ordinary methods, but did not hit upon the plan of using the regular molecular stratification of a crystal to produce the cumulative dispersion required. Moseley and G. G. Darwin were the first to get diffraction effects, and the X-ray spectra of different elements. Directly X-ray spectral analysis was achieved, it was anticipated that information might be expected about the structure of the atom.

In his youth, Sir Oliver continued, spectrum analysis had seemed very simple. A certain yellow line was due to sodium, another line to magnesium, and so on. With further investigation, however, matters became more complicated, indeed, terribly so when it was found that one and the same element gave different lines when excited by a spark, an electric arc or a flame. It began then to seem as if the atom must be a terribly complicated structure. Indeed, he remembered W. K. Clifford saying that the atom must be at least as complicated as a grand piano, and this was certainly how it seemed when looking at the spectrum of an element. Trying to make a model from a spectrum by examining the whole of it and not merely the visible part, was equivalent to trying to make a model of a grand piano by listening to the sound it gave out when thrown down stairs. In fact, radiation could only be got from the atom by subjecting it to violent shocks.

Ultimately, however, Moseley showed that the atom of hydrogen was not a more complicated system than that of the earth and moon. This being so, how on earth was the hydrogen atom able to emit all the lines found in its sprectrum. The explanation was found by Bohr who said that the atom was not complicated, but there were many possible orbits in which the electron might revolve. He specified these, assuming that the electron could not revolve in any other orbits, and that it produced radiation when it dropped from one of these stable orbits to another. If in the lowest orbit it could not drop further, but it could be raised out of this by X-rays (and in certain cases by ultra-violet light) either to another stable orbit or "to infinity," which in this case meant, perhaps, half a millimeter, or somewhere out of reach of the atom. It could then drop in again, and, when it did, we got the characteristic spectrum of the atom in question, which was strictly of a monochromatic character. The whole of the bright line spectrum was thus produced.

We had long been taught that the molecule and atom were too small for analysis by anything in the nature of vision. Ordinary visible light had a wave length of about $\frac{1}{100,000}$ of an inch, but this, though small, was 5,000 to 6,000 times as great as the diameter of an atom. If we used ultra-violet light we might get wave lengths of one-tenth or one-twentieth that of visible light, but this was still very coarse in comparison with atomic dimensions. Analysis by crystals had, however, shown that some X-rays had a wave length of less than atomic dimensions, and, nevertheless, these were fortunately able to impress silver salts and yield photographs. It thus appeared that a probe for penetrating into the secrets of the atom was in our hands. To get results, however, required skill, and to interpret them, a touch of genius. Moseley showed that a comparison of the X-ray spectra of successive elements showed a series of regular steps. Here was a proof that the atom possessed some quantity which increased in equal steps as we passed from one element to the next, and this Moseley laid down could only be unit changes in the positive charge at the nucleus.

The indivisible unit of positive electricity was a kind of quantum numerically equal to the electron, and Moseley surmised that it was by this unit that each element differed from the one below it. The elements could thus be arranged on a staircase of equal steps with hydrogen on the first, helium on the second, and so on. So far we had found 92 steps, but some hoped, without as yet adequate proof, that we should get up to 118. This hope was based on the fact that the inert gases were the most symmetrical atoms. Argon was the first of these to be discovered by Rayleigh, and Ramsay had added many others. The list started with helium, and we then had neon, argon, krypton, Xenon and niton, and the next in order would have an atomic number of 118. This had been looked for by positive ray methods, and the speaker had hoped that Aston might thus have found it.

We now knew that each step of the staircase of the elements might be occupied by different elements, whilst in other cases the same element was found scattered over different steps, so that its mean position might be fractional. If we considered an element as a ball resting on the staircase, then what we had been accustomed to call one element might be represented by balls on different steps. When a ball tumbled downstairs it gave out a noise, and this was equivalent to the phenomena of radioactivity.

There were thus marked discontinuities as we passed from atom to atom. Some years ago the speaker had given an address to the British Association on continuity, but ever since discontinuity had proved to be the most important fact in physics. The way in which the subject had been invaded by arithmetic was most amazing. We now counted things that we never expected could be counted, and whilst previously such things as we did count were rendered countable only by artificial conventions as to the units used, we now met with natural units in the atoms, electrons and quanta. Indeed some now thought that discontinuity reigned everywhere, but the doctrine should not be gratuitously extended, as for instance to space and time. Here, however, the speaker differed from some other philosophers, and the latter, he said, might be in the right.

It was a mistake to suppose that the quantum had disposed of the ordinary laws of mechanics, which were, in fact, merely limited by the discontinuities introduced by the quantum and the proton.

Bohr of Copenhagen, one of the most remarkable geniuses of our time, had found that this discontinuity was met with inside the atom in the regions round the nucleus. Here we had another staircase, the steps of which were represented by the stable orbits in which alone an electron could revolve, and when it dropped from one to another radiation was emitted.

In the case of the hydrogen atom, if the innermost or K orbit had a radius represented by unity; the next, or L orbit, had a radius of 4, the M orbit of 9, and so on, the interspaces between the different orbits being thus represented by the odd numerals.

When an electron was on, say, the M orbit, it was quite as happy as if on a level surface and might go round and round for ever. If it dropped into the L orbit, however, it would make a "splash," and in some way unknown, it then emitted light of a definite wave length, just as a cathode ray on striking a target made the latter give out a single line. If the electron dropped to the L orbit from an orbit outside the M orbit, it would make a bigger splash and give rise to a line of shorter wave length. In this way a series of spectral lines

were obtained, all due to electrons falling from outer orbits into the L orbit, and these lines corresponded exactly with those in the visible spectrum of hydrogen. If, however, an electron dropped into the K orbit instead of into the L, very much more energy was liberated as radiation and another series of lines was emitted almost exactly like the former, but having one more line, viz., that corresponding to the drop from the L to the K orbit. The spectrum thus obtained lay in the ultraviolet and was known as the Lyman series. If, on the other hand, electrons fell into the M orbit, we got a series in the ultrared, known as the Paschen series, which contained one line less than appeared in the visible spectrum.

The foregoing was a summary of Bohr's explanation of the hydrogen spectra. If we took a more complex atom with a more strongly charged nucleus, the stable orbits were crowded closer together, the field was much more intense, and most of the lines of the spectrum lay in the ultraviolet and ultimately in the X-ray region. Indeed the hydrogen lines might also be considered to be X-ray spectra, one set of which happened to lie in the visible region. All bright line spectra were due to the drop of an electron from one stable orbit to another. If we wanted to excite the characteristic X-ray spectrum we had to eject an electron from the atom by bombarding the latter, and as the electron fell back again the radiation was emitted. The cathode rays used, however, did not give rise to these rays only, but to a continuous spectrum with the characteristic bright lines superimposed on it.

X-ray operators required to vary the hardness of the rays used. If too hard, contrasts would not be brought out, whilst if too soft the penetration would be insufficient. The progress of physics had provided means for analysing X-rays, but what was still more remarkable, the theory of atomic structure made it possible to say what kind of rays we might expect from a stated target. These rays had revolutionised crystallography. Even when dissolved, the atom formed just as efficient a target, and Dr. Owen had obtained the X-ray spectrum of one metal dissolved in another.

The means employed to measure the wave length of X-rays originated with the late Lord Rayleigh, who had explained the colour of the opal and of crystals of chlorate of potash. In these cases the twinning of the crystals gave rise to a regular stratification, the thickness of which was comparable with the wave length of ordinary light. Each stratum reflected a very little light of the appropriate wave length, but the reflections from the different strata reinforced each other. Lord Rayleigh had illustrated his results by showing that sound could be reflected from a series of layers of muslin, which he mounted on lazy-tongs, so that he could readily adjust the spacing. With this arrangement he got regular reflection of the sound emitted by a whistle of too high a pitch to be audible, but to which a sensitive flame readily responded.

In such reflections it was necessary that the spacing of the reflectors and the angle of incidence of the radiation should be such that the successive reflections when they combined into the single reflected ray were in the same phase. If this were the case then, although each layer reflected very little, the resultant reflected ray was readily perceptible. The necessary relation between the spacing, the angle of incidence and the wave length was $\lambda = 2\ d\ \cos\theta$, where λ was the wave length, d the pitch of the layers, and θ the angle of incidence. In this way Rayleigh explained the colours of the opal, and following the same line Moseley had obtained his X-ray spectra. The Braggs had similarly analysed crystal structure by using X-rays of known wave length and thus determined the distance d between successive layers of the atoms constituting the crystal

Messrs. Schall & Son had, moreover, produced an X-ray spectrometer by which the voltage applied to an X-ray tube could be measured. The energy with which the cathode ray struck the target in such a tube was e V, where e was the natural unit of electricity and V the voltage. The energy of the shortest wave length sent out by the target was equal to this and also to $h\nu$ where h was Planck's quantum and ν the frequency. Hence we had

$$e\,V = h\,\nu$$

But if c denoted the velocity of light and λ the wave length, we had

$$\nu = \frac{c}{\lambda}$$

so that

$$\lambda\,V = \frac{h\,c}{e}.$$

Every term on the right of this equation was a known natural constant. Hence if we expressed V in kilovolts and λ in Angström units of 10^{-8} cm., we could write

$$\lambda\,V = 12{\cdot}4$$

Thus by measuring the shortest wave length emitted by the target we could determine by this simple formula the voltage applied to the tube.

The whole of the Bohr theory depended upon the theory that the atom consisted of a central positively charged nucleus around which electrons revolved in certain definite orbits which had to be in accord with the correct law of force.

This was not the only view of atomic structure which had been considered. At one time a law of force varying directly as the distance had been proposed because in that case the time of revolution did not depend on the distance. With the inverse square law it did, but it seemed impossible with this inverse square law to account for anything but a continuous spectrum. Indeed this difficulty had not been even yet got over. Bohr, in fact, had merely assumed the quantum hypothesis and tried how it worked, and on this assumption had found that inside the atom, as in astronomy, the radius vector to an orbit passed over equal areas in equal intervals of time. Thus if a certain area of the K orbit of hydrogen were swept over in unit time then an equal area of the L orbit would be described in twice this time, whilst the corresponding period for the M orbit would be three, and so on. These conclusions had been justified by observation.

The next question that arose was whether the orbits need be circles. It was possible to have elliptical orbits at the same energy level. All these would have the same major axis and the same time of revolution. Thus whilst the K orbit must be circular the L orbit might be an ellipse with its minor axis half the major axis.

Again, the fourth orbit might be an ellipse in which the major axis was three times the minor, and so on. In any of these orbits the electron would have the same energy as if it pursued a circular path. There was, however, one difference. On the electrical theory of matter the mass varied with the speed of motion, at least when the speed was sufficiently high, as it was inside the atom. In the ellipse the speed did vary a lot and hence we had to apply the astronomical laws to the movement of a satellite of varying mass. It then turned that under these conditions the orbit did not form a closed curve but the ellipse revolved round, so that successive orbits gave a sort of rosette. This was proved to be the case with the planet Mercury, and inside the atom it led to the result that each X-ray should be doubled and on close examination this was found to be the case. This observation could only be accounted for on a kinetic theory of the atom, and the static model which the chemist found so handy for describing his compounds failed here. The physicist, however, was obliged to hold to the kinetic model as it explained every detail of the observations.

It might be taken as settled that there were these energy levels within the atom in which an electron could rotate without loss of energy by radiation, this being emitted only when the electron jumped from one energy level to a lower one. This was the observation, but no explanation of it had yet been forthcoming.

In these conditions it was permissible to make even wild surmises, which could be tolerated until the true explanation was found. He would suppose, therefore, that the nucleus was in a state of violent rotation. It had always been a puzzle why the latter was more massive than the electron, and he suggested that this was due to its violent rotation, the speed being such as to increase the mass to 1,850 times that of the electron. He would next assume that surrounding the nucleus the ether was in rapid circulation constituting a sort of vortex. In this vortex there might be stream lines at which the speed was the same as that of an electron revolving at the same distance under a force attracting it to the positive nucleus by the inverse square law. If this was the case the electron would revolve round with the ether stream and could be regarded as a sort of solidified particle of the ether, and it would then have a permanent circular orbit in which it could revolve without producing radiation since it was moving with the ether and at the same speed.

In this way we might find in the suggested ethereal whirl different levels in which the electron could revolve as explained. In the intervals between these, no stable orbits would be possible, and if the electron fell into a lower orbit it would on arriving there oscillate for some time about its mean path, and in these oscillations radiation would be emitted proportional to the energy due to the fall from the one level to the lower one.

He had hoped, he concluded, to have brought this suggestion before the recent meeting of the British Association, where the experts would have had the opportunity of squashing it, but lack of time prevented this being done, and he now exposed it accordingly on the doorstep of the Röntgen Society.

THE LATE DR. JOHN EDWARD STEAD.

As briefly announced in our last issue, the death occurred at his residence "Everdon," Redcar, on October 31, of Dr. John Edward Stead, F.R.S., the well-known scientist and metallurgist, and a past-president of the Iron and Steel Institute. Dr. Stead was a man of so many real accomplishments and of such true geniality that we feel it very difficult to do him full justice in an obituary notice however detailed that may be. The late Mr. William Whitwell, also a past-president of the Institute, no doubt experienced the same difficulty as we do when, as early as 1901, he handed to Mr. Stead, as he then was, the Bessemer medal for that year. Mr. Whitwell used the following very brief, but very characteristic terms: "It gives me great pleasure to present you with this medal. That you are deserving of it, I need not say. As to the appreciation of your services by this Institute, I will not multiply words. We are grateful to you for the work which you have done. It has helped many of us more than we can tell; and in the future I trust that those services may be continued for the good of England and the world." Twenty years later, when asking his friend, Dr. Stead, to take the presidential chair of the Institute, Mr. E. Schneider, the retiring president, said that "Dr. Stead had long enjoyed a world-wide reputation in metallurgical science, and had rendered it possible to decipher by chemical reagents those mysterious hieroglyphics which were impressed in steel and which revealed through the microscope the history of the metal and the different phases it had gone through." Both these very brief statements speak volumes for the accomplishments of Dr. Stead, for the work he carried out in metallurgy, and for the esteem in which he was held by every iron and steel manufacturer both in this country and abroad.

Dr. Stead was born at Howden-on-Tyne on October 17, 1851, the son of the late Rev. W. Stead, a Free Church Minister. He was educated privately, and whilst still quite young he entered as an apprentice the service of Mr. John Pattinson, a chemist in Newcastle, under whom he studied analytical chemistry. He then entered as an analytical chemist the Hebburn Works of the Tharsis Sulphur and Copper Company. Later, he was appointed analytical chemist with Messrs. Bolckow, Vaughan and Co., first at their Manchester establishment, then at their Middlesbrough Works. He left the service of Messrs. Bolckow, Vaughan in 1876, and established partnership with his first employer, Mr. Pattinson, the firm having since been styled "Pattinson and Stead." The present laboratory at Middlesbrough was then established, in addition to that which existed at Newcastle, a laboratory in

which many present-day well-known metallurgists received a most successful training.

A very large number of suggestions and inventions in the realm of metallurgy are due to the genius of Dr. Stead. One of his most important practical developments may be said to be the after-blow in the basic Bessemer process, to which he very briefly alluded in his presidential address to the Iron and Steel Institute delivered in May, 1920. The thorough dephosphorisation of the bath in the early days of the process was a difficulty which had baffled every manufacturer. Trials with the basic process at Messrs. Bolckow, Vaughan's Works led him to the conclusion that the secret of dephosphorisation resided in the prolongation of the blowing after the carbon had been removed, the effect of the after-blow being the production of sufficient oxide of iron to oxidise the phosphorus. After failure had followed failure without the after-blow, at his urgent request and notwithstanding the eventual risks it entailed, the possible consequences of which he agreed to bear, a charge was overblown, and this very first attempt was completely successful, the ingots produced being rolled into perfect rails at the Eston Works of Messrs. Bolckow, Vaughan. This suggestion of his constituted the turning-point in the basic Bessemer process.

Dr. Stead may be said to have been concerned with micrography from the very beginnings of this new science, and he wrote a book in collaboration with the late Mr. Osmond on the "Microscopic Analysis of Metals," a book which may be said to be more of a practical than of a theoretical nature. In the preface to the second edition of this, Dr. Stead, stated that he wished to keep the book in its original form as an historical monument to the memory of Osmond. For the eminent French scientist he always entertained the highest regard. This preface would seem to imply that although Dr. Stead was profoundly impressed—as were, in fact, all metallurgists throughout the world — with Osmond's theory when this was first put forward, he did not invariably quite agree with it ultimately. Dr. Stead was not dogmatic in any way, but, on the contrary, was most broadminded; he always and consistently moved with the times which he himself strongly influenced, and was ever open to correction.

Dr. Stead introduced a law on welding, according to which true welding is effected when two pieces of metal become one single, whole piece, the crystals in each overstepping or flowing across what was previously the line of demarkation. There is no welding, according to his law, until the crystals become common to the two pieces and form single units. He also devised a machine and tests for alternate bending, and dealt extensively with grain growth and brittleness. His reagents for phosphorus, in macro-etching are most valuable and are extensively used in laboratories and works.

"Steadite" is a name given by Sauveur to a very distinctive occurrence in grey pig-irons, one which once seen is readily recognised; it is the eutectic of not quite pure Fe and Fe_3P. This occurrence, unfortunately, is seldom spoken of as "steadite," but is termed "phosphide eutectic"; it is not a lamellar type of eutectic but occurs in the form of small bars in the shape of dumb-bells. The fact that Dr. Stead's name has been given to a welding law, to reagents and to a microstructure serve to prove that he was throughout his whole career a pioneer in the realm of scientific metallurgy.

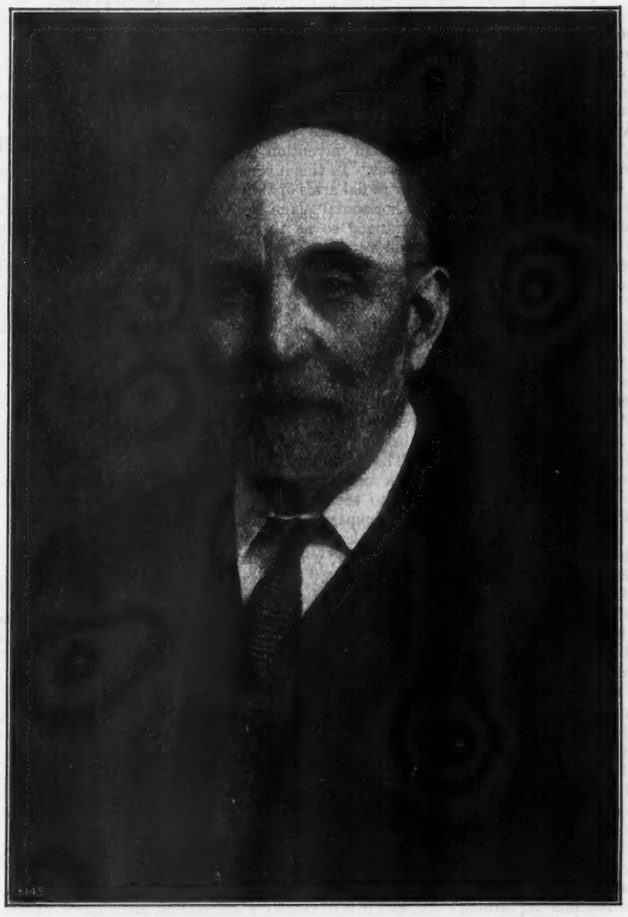


Photo. by Maull and Fox.

THE LATE DR. JOHN EDWARD STEAD.

Dr. Stead became a member of the Iron and Steel Institute in 1873; he was elected a member of council in 1895, a vice-president in 1910 and president in 1920. His original contributions to the Institute were very numerous, commencing with one he read in 1880 on "An improved instrument for the Analysis of Blast-Furnace and Other Gases." His papers cover the manufacture of iron and steel in every one of its phases; they also deal with the effect upon steel and iron of impurities and metallic additions, metallography, &c., and are of the utmost practical value. He regularly attended every meeting and took part in almost every discussion, until a few months ago, when ill-health prevented him from leaving his residence. We may here add that in the opening statement of his presidential address to the Institute to which we have referred above he said that Sir Lowthian Bell suggested at a council meeting, "years ago," that he, Dr. Stead, should be elected president at that time. "Whilst recognising the personal compliment," Dr. Stead "did not consider that he was qualified to accept such an exalted position." This is another fact which emphasises the merits of the man and testifies to his modesty. Besides his original papers, read before the Institute Dr. Stead contributed others in conjunction with different members, including Mr. C. H. Ridsdale, an early collaborator and constant friend of his, Mr. A. W. Richards, Professor Carpenter and others. His contributions to other societies were also numerous and important. "One of Dr. Stead's greatest faculties," Mr. Ridsdale once informed us, "was to fire young chemists with enthusiasm for working at scientific problems, and he brought forward in joint papers many who were too diffident to attract attention unaided." To our personal knowledge, on more than one occasion he has announced in his own reports that he owed such and such a suggestion to a young worker in metallurgy whose name he freely stated, thus giving credit where credit was due, and indirectly encouraging the young worker to further activity. Dr. Stead was president of the Cleveland Institution of Engineers in 1895–1896. He was a Fellow of the Institute of Chemistry and a member of Council of that body. He was also a Fellow of the Chemical Society and was elected a Fellow of the Royal Society in 1903. The American Institute of Mining Engineers elected him an honorary life-member. In 1910 the University of Sheffield conferred upon him the degree of Dr. in Metallurgy, while in 1912 the University of Leeds, and in 1914 the University of Manchester both conferred upon him the degree of Dr. of Sciences. Dr. Stead was president of the Chemistry Section of the British Association in 1910, when it met at Sheffield, and a member of other technical societies.

Although Dr. Stead was an indefatigable worker in science and metallurgy, he found time to act as a magistrate for the North Riding of Yorkshire, as a member of the Guisborough Board of Guardians and as governor of the Grammar School at Coatham, Redcar. Education of the young workers of the country may be said to have been one of his hobbies. For many years he was an examiner in iron and steel manufacture to the City and Guilds of London Institute. He most gladly arranged series of lectures to workers in iron and steel, and was gratified to find them intelligently interested in the

subjects of which he had made his life study. He was an ardent advocate of the technical training of employees with a view to increasing their efficiency to the benefit of the industries with which they are concerned and as a justification of a fairer remuneration. He found primary, secondary and technical education to be imperative, also the after and constant education of graduates when once they entered the works.

Such was—very briefly written—the man whose demise leaves a very great void in the scientific world. His work, his invariable kindliness and ever willing help will long be retained in the memory of a host of his fellow-countrymen, young and old.

IMPROVEMENTS IN AIRCRAFT COMPASSES.

Although within recent years the magnetic compass, as applied to marine navigation, has met a formidable rival in the gyroscopic compass, the former still remains the standard instrument in this particular application. Its behaviour under marine conditions is well understood by navigators and its indications are generally reliable. This, however, is far from being the case when compasses of somewhat similar design are fitted on aircraft, as was done in the early days of aviation. Many difficulties have been encountered in applying the instrument to aerial navigation, the chief of these being due to the oscillations of the needle in cross-country flights and what is known as the northerly-turning error.

These difficulties were dealt with by Mr. H. E. Wimperis, Superintendent of the Air-Ministry Laboratory, at the Imperial College, South Kensington, in the course of an interesting paper describing recent developments in aircraft instruments read by him before the Royal Aeronautical Society on the 1st inst. The author explained that when an aeroplane banks, the magnetic system of the compass remains normal to the apparent vertical, which is the resultant of the vertical acceleration due to gravity and of the radial acceleration due to the turn. The vertical component of the earth's magnetic field thus has a component in the plane of the compass card, as well as the horizontal component which normally controls it, the magnitude of the former component being proportional to the sine of the angle of bank. The vertical component of the earth's field is stronger than the horizontal component in the same ratio as the tangent of the angle of dip is larger than unity, and from this it follows that in the simple case of a machine flying on a northerly or southerly course, the sine of the angle of deflection of the compass needle will be larger than the sine of the angle of bank in the same ratio. Hence an angle of bank of 1 deg. tends to produce an angle of deflection of the compass card of 2·15 deg., since 2·15 is tan 65 deg. and 65 deg. is the angle of dip. If the design of the compass card is such that it responds very rapidly, a deflection of this amount will be indicated and the effect will be experienced even when the machine is flying on a so-called straight course, since the latter is actually made up of a series of curves of large radius, owing to the pilots' use of the rudder and ailerons to correct the yawing of the machine. In "bumpy" weather, the oscillations in banking may be of the order of 5 deg. in either direction, and, in these circumstances, a rapidly moving compass needle would tend to oscillate over a range of some 20 deg. and would therefore be practically useless.

Apparently the difficulty could be overcome by weakening the magnetic moment or by increasing the inertia of the moving system for the purpose of slowing down its motion, but these remedies are limited, in practice, by the fact that if the magnetic couple is made too low the pivot friction will cause the card to stick, and the same effect would be produced by increasing the weight and dimensions of the card to increase its moment of inertia. Increase in the size of the card would also introduce an error due to the swirl of the liquid carried round by the rotation of the bowl. What is actually required is to increase the damping of the moving system without increasing its weight or inertia, and this requirement was met by the work of Campbell and Bennett at the Admiralty Compass Observatory in 1918. They employed radial "feelers" of thin wire attached to the magnetic system, the effect of these wires being to dissipate the energy of rotation by setting up minute eddies in the liquid through which they move. By this method it is possible to make the movements of a compass truly aperiodic, although experience indicates that this is generally undesirable. In practice it is found best to keep the amount of damping at about 70 per cent. of that which would cause the motion to be just aperiodic.

Another important point in compass design dealt with in the paper is the period of oscillation of the moving system. In the earlier compasses in which but little damping was provided, it might happen that the periodic time of the compass coincided with one of the several oscillation periods of the aeroplane, when violent oscillations of the compass card would be set up. To avoid this, compasses were designed with very long oscillation periods, but these proved unacceptable to pilots from their sluggishness. In practice it is necessary to adopt the best possible compromise between the two opposing characteristics of excessive oscillations on the one hand and undue sluggishness on the other, and this compromise has been greatly aided by Dr. Bennett's recent invention of the centesimal scale for compasses. In this invention, the card is replaced by four radial arms of thin wire extending outwards in a horizontal plane from the magnetic system and arranged so as to form three angles of 100 deg. each between them and one angle of 60 deg. The four arms carry the numbers 0, 1, 2 and 3, that carrying the figure 0 pointing north, and their ends move near a fixed segmental scale graduated from 0 deg. to 100 deg. and occupying a position corresponding to that of the usual lubber's line. A moment's consideration will show that reading the number carried by any one of the arms in conjunction with that indicated by the position of the arm relatively to the fixed scale will give the angular bearing of the machine in degrees from north. The arrangement thus gives all the advantages of a card compass without the disadvantages due to the weight of the card.

The design of compasses for aircraft, however, is complicated by another consideration known as the northerly-turning error, which was first discovered at Farnborough in 1915. This error arises in the following manner: When an aeroplane flying on a northerly course begins to turn with a banking movement, the compass needle will tend to move through an angle of 2·15 deg. per 1 deg. of bank, as already explained. Whether it will actually do so depends upon the time available, but obviously if, at the same time, the aeroplane should also turn in the same direction through 2·15 deg. the compass would indicate no turn at all. If, on the other hand, the aeroplane turned slower than the compass card, a turn in the correct direction, but smaller in magnitude than that actually made, would be indicated, and, in the same way, if the aeroplane turned faster than the card the latter would indicate a turn in the wrong direction. This indication of a turn in the wrong direction is known as the northerly-turning error, and it is obviously a serious one, since it would lead the pilot to employ movements of the controls in the opposite sense to those actually necessary to correct his flight; the error, in fact, has often been the cause of dangerous spins, particularly when flying in clouds. The use of the gyro turn indicator would, of course, obviate this difficulty, and Mr. Wimperis pointed out that the common practice of using the compass in the dual capacity of turn indicator and direction indicator is bound to lead to a more or less unsatisfactory compromise in compass design. The author mentioned also that laboratory tests had confirmed the theoretical prediction that if a compass shows a northerly-turning error at any one rate of turn it will show it at all rates. The existence of the error, however, is largely dependent on the air speed of the machine, but it is less in evidence in compasses having a long periodic time. Increase in the damping factor also tends to reduce the error.

The paper contains an approximate analysis of the motion of a compass-needle during disturbed flight, and the author showed a series of curves of the oscillations with different degrees of damping obtained by calculation. These were in remarkably good agreement with similar curves obtained from the results of experiments made in the Air Ministry Laboratory by Mr. A. P. Rowe. Incidentally the experimental curves showed the great improvements in the characteristics of modern aircraft compasses in comparison with those of earlier designs. Experimental methods, we may mention, have been developed, and are now in use in the laboratory, for testing compasses for steadiness of reading and for northerly-turning error, and, although the ultimate appeal must always be to tests made in actual flight, the laboratory testing methods enable preliminary observations to be made more rapidly and with much greater facility than would be possible in the air. Based on this work, it has been possible to draw up designs for new types of compasses which will succeed the older types as soon as the large war stocks of the latter still in existence are consumed. It is thought that two types of compasses for pilots and two for observers will meet all requirements of aerial navigation. Even this small number of types, the author pointed out, would be reduced materially by the general employment of the gyro turn indicator.

SAFETY OF LIFE AT SEA.

At the Institution of Mechanical Engineers on Friday last, the tenth "Thomas Hawksley" Memorial Lecture was given by Sir Westcott Abell, K.B.E., M.Eng., who took for his title "The Mechanical Problems of the Safety of Life at Sea." This is a subject with which the lecturer has for long been associated, and it is of especial interest at the present time owing to the recent report of the Merchant Shipping Advisory Committee on Life-Saving Appliances.

At the outset of his lecture, Sir Westcott Abell paid tribute to the high standard of safety already obtained in ocean travel, and pointed out the great increase in safety which arises by the development of wireless telegraphy and similar devices which, as he remarked, have "added another sense to the nervous system of the ship." It is to be expected, therefore, that the number of casualties in future will be less than in the past. But it is obvious that despite the increase of safety, casualties will still happen from time to time, just as accidents occasionally happen on railways, notwithstanding their elaborate system of safeguards and set time-tables. Even if a casualty does occur, the introduction of wireless and the extension of sea travel have definitely altered the character of the problem. Only in rare circumstances is the captain of a sinking vessel faced with the necessity of transporting his passengers and crew to the nearest land; the first question now is to delay the sinking of the ship as long as possible, in the hope that wireless appeals will attract a vessel in the neighbourhood. Even if it becomes necessary to take to the lifeboats, help will probably arrive within a few hours, except in unfrequented waters.

In these circumstances, the question of internal sub-division by watertight bulkheads becomes of considerable importance, particularly in the case of large passenger vessels where the hazards of abandoning the ship must in any case be considerable. The lecturer rightly devoted considerable attention to this phase of the subject, and discussed the vital question of the necessary openings in bulkheads and sides of vessels, which are inevitably weak points in the ship's protection system. While reiterating the fact that "the best doors are no doors," he pointed out that much might be done to minimise the danger by suitable mechanical devices for controlling watertight doors from the deck or bridge, and by adopting arrangements which limit the number of sanitary and other openings in the ship's side. In this way the effective value of subdivision may be considerably increased.

In this connection the lecturer referred to the great increase in the use of oil fuel, and pointed out the advantages arising from the custom of carrying oil in side bunkers with inner bulkheads parallel to the ship's sides, and, say, about 15 ft. distant. The use of oil, he said, had brought about increased safety from the sub-division point of view, for although the ship's side might be damaged, yet it was fairly unlikely the inner skin would be affected, and further, if the oil tanks in the region of damage happened to be full, the water would be excluded.

On the other hand, however, Sir Westcott pointed out that experience shows where a vessel is so badly damaged that her bulkhead system affords no protection against sinking, only a short time is available in which to take to the boats, and he suggested the time available is likely to be about 30 minutes. With such a short time limit the value of early information as to the extent of damage is obvious, and there was need for some devices which would do away with the necessity for the presence of water or fire in the main compartments of the ship to be ascertained by individuals and transmitted to the bridge. If this were possible (and something of the sort has already been done as regards the fire risk) the time available after the captain's decision to abandon ship would be appreciably extended—and in a casualty, time is all-important.

The abandoning of a modern liner in mid-ocean is a most serious operation, and the provision of proper appliances to provide for such a contingency is one of the most thorny problems with which shipowners have to deal. In discussing the matter, Sir Westcott Abell drew emphatic attention to the necessity for simplicity. If there was one thing more clear than another, it was that simplicity—making everything fool- and brute-proof—was the essential. A boat can be lowered by one rope at each end; there should be no mistake about that one rope, and it should be capable by the aid of bitts to be lowered by two men to each rope. There are those who hold that power appliances will solve the problem, but one blown fuse in the main circuit from the emergency dynamos may put the whole or a half of one side out of action. The ultimate test of efficiency must be man-power.

On the larger type of vessels which cannot carry all the necessary boats in one line attached to davits at the ship's sides, the problem of suitable boat-lowering arrangements becomes of extreme importance, and Sir Westcott Abell's views as to the essential requirements for davits in such vessels are:—

"(1) Davits should be capable of taking two boats together, each boat having separate attachments for the lowering ropes at each davit. (2) The davits should be able to put both boats over the side at once against a list of at least 10 deg. and perhaps as much as 15 deg. (3) The lowering ropes should be kept separately, and bitts provided for each rope, so that two men can control the lowering of each end of a boat. (4) As it is preferable to stow boats outboard, means must be made to bring the davits and boats inboard rapidly for harbour and quay purposes. (5) The control of the movement of the davits from the harbour to the lowering position must be extremely simple—gearing should be avoided as far as possible, and any gearing should be shrouded and protected from accumulations of paint, dirt, ice, water, or other foreign substances. Further, the simpler the gearing the more often and the more readily will all concerned work for its proper maintenance."

With regard to the fourth point mentioned above, it is to be noted that the question was raised in the Merchant Shipping Advisory Committee's Report as to whether boats could be carried slung out or with their keels at the ship's sides, to avoid lifting the boat should a list occur. Naturally, no hard-and-fast rule can be laid down on this point, since boats could hardly be carried outboard in bad weather. No one will deny, however, its advantages in the case of sudden casualty.

Sir Westcott also drew attention to the advantages attending the provision of light rafts which can be man-handled over the side. Experience has shown that the panic legislation following the Titanic disaster has not materially increased the safety of life at sea. The provision of "boats for all" cannot reduce the risk unless there are adequate means by which all the boats may be lowered to the water within a short time limit; but the development of wireless telegraphy has definitely increased the value, from the point of view of safety of life, of light buoyant apparatus which is designed to support passengers in the water until help arrives, and which can be used on both sides of the ship. A heavy list may easily make it impossible to use at least half of the full boat accommodation. In such a case, light buoyant apparatus may make all the difference between a casualty and an appalling disaster.

That such a lecture should be read before the Institution of Mechanical Engineers is evidence of the increasing attention which the technical world as a whole is devoting to the subject of safety of life at sea, and the lecturer is to be congratulated on presenting a clear and comprehensive summary of the main phases of the problem.

NOTES.

Internal Water Transport in Russia.

Last year the German small steamship Pionier, leaving Hamburg, made an experimental trading passage through internal waterways, and ultimately reached Enzeli, on the Caspian. Through the Gulf of Finland and the Neva she reached the Maria Canal system, by which she entered the Volga, and traversed that river to Astrakhan and the land-locked sea. The canal system had fallen into some disrepair during the war, but has now been reconditioned. Another vessel, the Enzeli, built for the same service, has now set out on a passage to the Caspian, and two others motor-driven, of 1,000 tons to 600 tons, are being built at Rustringen, as well as two additional vessels in Sweden. The line is being run by the German-Russian Transport Trading Company, founded by the Soviet Government and a German consortium. German exports will thus reach inner Russia, the Caspian and Persia, while Russian products will be transported to places on the rivers, or exported to Germany. An American company is reported to have secured the concession to construct a navigable canal between the Volga and the Don, which will bring these waterways into communication with the Black Sea and the Mediterranean. A further project is to form a navigable waterway between the Caspian and the Sea of Aral. The Baltic and Black Sea Company recently established at Warsaw proposes to undertake the improvement of the Vistula and Dniester, and the canals, making them navigable for ships of moderate size trading between the Baltic ports and the south.

Proposed Road Bridge Across the Forth.

The erection of a road bridge across the River Forth, east of the present railway bridge, but converging towards it at North Queensferry, has been proposed by Mr. J. Ingles Ker, as a means of linking up the thoroughfare to the North of Scotland. It would connect up the road route from Dover to John o' Groats, and would greatly increase the usefulness of the bridges contemplated at Berwick-on-Tweed and at the Tay. In addition, should the scheme be carried out it would certainly enhance the value of the new highway between Glasgow and Edinburgh by giving direct connection with Dunfermline, Kirkcaldy, Perth and Dundee. The details of the construction have now been worked out and were submitted by Mr. Leitch of Messrs. Leitch and Sharpe, of Glasgow, at a meeting on Friday last at South Queensferry. The road on the proposed bridge would have a width of 58 ft., consisting of two 9-ft. footpaths at the sides and a 40-ft. roadway. From a point on the public road from Edinburgh to South Queensferry which is 150 ft. above high water level, this being about the height of the present railway bridge, it was proposed to run out an embankment of about 200 yards length. At the end of this a masonry abutment would support the girders of the first span of the approach viaduct, and this viaduct would be carried over masonry piers for a distance of 560 yards to the south pier of the suspension bridge. The central portion, it was suggested, should consist of two spans of 2,400 ft. each, and support would be provided on a central pier on Inch Garvie. A similar viaduct to that on the south side, but of 660 yards length, would extend from the north pier to the face of the whinstone quarry workings at Carlingnose, and the road would be continued for about 50 yards to join the existing public road at North Queensferry. The construction was estimated to cost between 2,500,000*l.* and 3,000,000*l.*, and would take five years for its completion.

The Significance of Cracks.

In his Memorandum to the Manchester Steam Users Association recently published Mr. C. E. Stromeyer describes experiences of this Association in respect to cracks in the dished end plates of boilers. These cracks occur in the angle at the flanged circumference of the plates, but in numerous instances the crack does not spread once it is formed. This is well shown by the following table:—

Boiler Pressure.	Diameter.	Thickness.	Radius of Root.	Remarks.
lb. per sq. in.	in.	in.	in.	
200	54	11/16	1¼	16 dished ends worked four years after first crack.
18	84	⅜	1	106 in. radius of dish—worked five years after first crack.
200	48	⅞	1½	Worked nine years after first crack.
200	54	13/16	1½	Worked nine years after first crack.
200	54	11/16	1¼	Worked two years after first crack. 24 plates in 12 other boilers had no cracks.

All these boilers were of steel save the second in the list. Mr. Stromeyer observes that a test pressure applied to a steel boiler has never yet produced cracks at the roots of the flanges of the end plates, and that the cracks must accordingly be attributed to fatigue. It may be noted that these observations afford a striking testimony as to the validity of the theory that, at any rate in the case of tough metals, secondary stresses, when non-alternating, are never responsible for a catastrophe. Mr. Stromeyer states the experience of years leads to the view that when cracks do appear in the roots of the flanges after some years' working, they relieve the stresses which are, of course, of a strictly "secondary" character. It appears therefore that in these cases, at any rate, the overload due to excessive secondary stresses is passed on to the less stressed portions, sometimes with, and sometimes without, any crack being produced. In the former case it is of course a matter of prudence to watch the crack, but the experiences stated indicate that there is no immediate danger. An accurate calculation of the stresses in a dished end would be a task of some difficulty, as the structure is indeterminate to a very marked degree. Equilibrium is in fact possible with a practically infinite number of "boundary conditions." If, however, the latter were assumed, it would seem that the problem of the stress distribution, ought to be soluble in terms of Legendre's coefficients, but the expansions might no doubt be troublesome to evaluate.

Royal Institution.—A general meeting of the members of the Royal Institution was held on the 5th inst. The thanks of the members were returned to Mr. F. Coston Taylor for his donation of 100 guineas to the research fund, and to Mr. Robert Mond for his gift of busts, medallions, portraits and photographs. The death of Professor Jules Violle, an honorary member of the Institution, was announced, and a resolution of condolence with the family was passed.

The Royal Society of Arts.—The Royal Society of Arts held the opening meeting of its 170th session on Wednesday last, the 7th inst., when Lord Askwith, chairman of council and a vice-president, delivered an address on "Exhibitions," which is dealt with on page 596 *ante*. Lists have been prepared of forthcoming meetings, among which we may mention one on the 14th inst., when Mr. Edouard Belin will deal with "The Electric Transmission and Reproduction of Writing, Designs and Photographs without Wires." Also two meetings in December, 3 and 10, at which Mr. A. F. Barker, professor of textile industries, The University, Leeds, will speak on "Recent Progress in the Wool Industries." Other papers to be read after Christmas will be found of special interest to our readers. The lists can be obtained from the Secretary, John-street, Adelphi, W.C. 2.

The Institution of Heating and Ventilating Engineers.—The Institution of Heating and Ventilating Engineers announce that three premiums will be awarded during 1924 in connection with an Assistants' Prize Competition for original papers on subjects connected with heating and ventilating. The Lumby premium (10 guineas) will be awarded for the best paper submitted in the competition, on heating. The Sirocco premium (also 10 guineas) will be awarded for the best paper on fan engineering; and the Preston premium (5 guineas) will be awarded for the next best paper on the above subjects. The competition is open to *bona fide* assistants actively connected with a business, or the profession, of heating and ventilating. Principals and employers are not eligible.

REINFORCED CONCRETE OVERBRIDGE AT WEMBLEY HILL STATION.

Fig. 1.

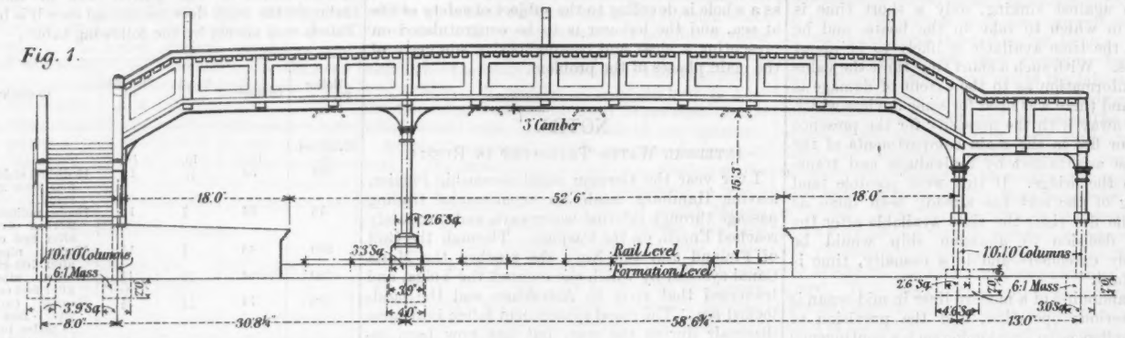


Fig. 2.

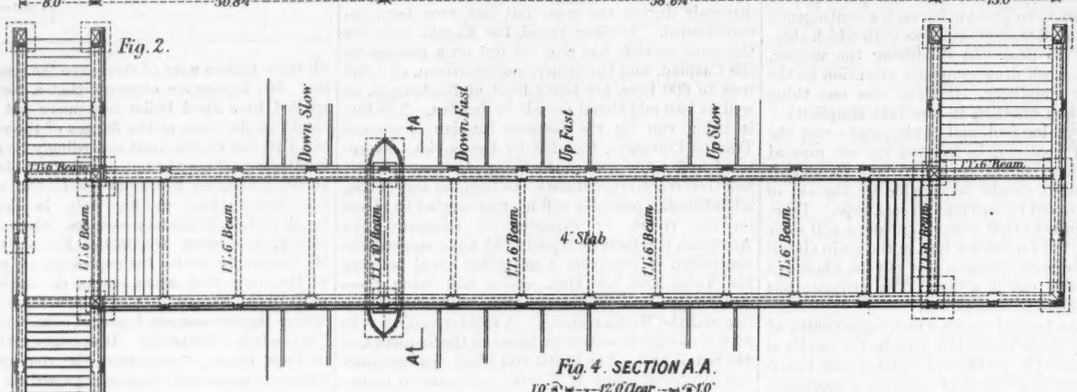


Fig. 3. END ELEVATION. DOWN SIDE.

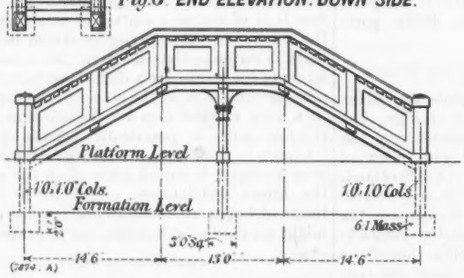


Fig. 4. SECTION A.A.

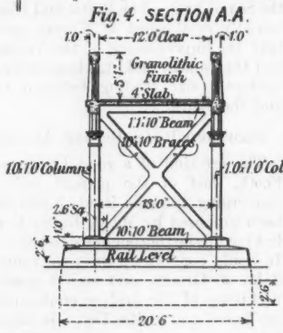
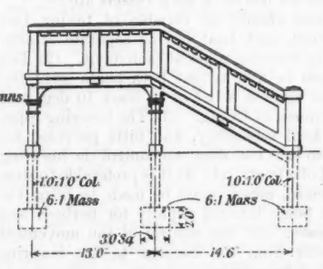


Fig. 5. END ELEVATION. UP SIDE.

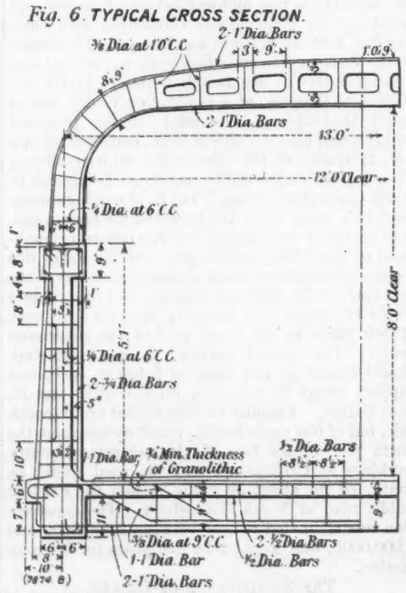


An accidental test of a rather unusual character was recently imposed upon a new reinforced concrete over-bridge at Wembley Hill Station, on the Great Central Railway, before the structure was actually completed, men being still engaged at the time of the occurrence on the surface finishing. The bridge in question is illustrated in Figs. 1 to 6, annexed, from which it will be seen that it connects two platforms, spanning four lines, and being supported by a pier which divides the total length into two spans of 30 ft. 8¼ in. and 58 ft. 6¾ in. respectively. On the up-side the bridge is approached by a stairway at right angles to it, while on the down-side two stairways are provided, one on either side of, and at right angles to, the longitudinal axis of the bridge.

Details of the reinforcement are given in Fig. 6, which shows the main beams to be 12 in. wide by 15 in. deep, the panels 5 in. thick (reduced to 4 in. in the centre of each panel) by 4 ft. 4 in. deep, and the coping 9 in. deep by 12 in. wide. The cross bearers are 9 in. deep by 6 in. wide, spaced about 7 ft. 4 in. apart cr. to cr. The deck slab is 4 in. thick. The pier dividing the bridge into two spans consists of two 12-in. by 12-in. columns spaced 13 ft. centre to centre, with 10-in. by 10-in. diagonal bracing between them, and 10-in. by 10-in. beams top and bottom. This structure is built upon a plinth, 20 ft. 6 in. long and 4 ft. wide, of mass concrete. Arched wind bracing extends over the bridge at three points, the form taken being indicated in Fig. 6, from which it will be seen that these braces are pierced, being 12 in. by 9 in. at the centre, and about 8 in. by 9 in. towards the sides.

On the occasion in question a goods train, in the early hours of the morning, was travelling on the down slow at about 25 miles per hour, and when approaching this footbridge one of the trucks became derailed. The derailment of this vehicle does not seem to have been observed, and after travelling some distance on the permanent way the truck collided with the pier of the bridge. The derailed wagon and the one following it immediately up-ended and jammed under the bridge as shown in the photographs reproduced in Figs. 7 and 8, on page 603, while the next two wagons also up-ended and the remainder crashed into the block thus formed, telescoping several, so that eight wagons were piled into a length which would normally be taken up by two. The destruction of the stock is well indicated in the views given, but an examination of the bridge showed that the main structure was undamaged. Not a crack was visible anywhere and the only harm done was at the points where the steel underframes of the wagons struck the bridge, chipping out small pieces of concrete and leaving the reinforcement temporarily exposed.

Fig. 6. TYPICAL CROSS SECTION.



The bridge was designed by Mr. Harry Blundell, M.Inst.C.E., engineer of the Great Central Railway. It was constructed by Sir Robert McAlpine and Sons, 50, Pall Mall, London, and the way in which it withstood the heavy impact, though quite a new structure, speaks well for the soundness of the design and the quality of the construction. The bridge was being completed to deal with the crowds which were expected for the recent Cup Final played at the new stadium at Wembley.

Bermuda Harbour Works.—Two schemes for harbour improvement are under discussion in Bermuda, says *The Canadian Engineer*. One proposal is to open up every available channel and erect wharves wherever possible at the principal islands, it being held that the colony depends entirely upon shipping. This scheme would entail an expenditure of about 175,000*l*. The other proposal is to dredge one channel (known as Dundonald) and provide a safe anchorage in the Sound at a cost of, probably, 20,000*l*. It appears that the latter course will be adopted, and later on there would be an extension of the harbour improvement scheme. The Board of Works will probably recommend that the work be done by the Colonial Government, a dredging plant to be acquired for the purpose.

REINFORCED CONCRETE OVERBRIDGE AT WEMBLEY HILL STATION.

(*For Description, see opposite Page.*)

FIG. 7.

FIG. 8.

THE INSTITUTION OF CIVIL ENGINEERS.

Presidential Address by SIR CHARLES LANGBRIDGE MORGAN, C.B.E.*

BEFORE proceeding to read my address I feel I ought to express my gratitude to the council for having nominated me as president, and also offer my warmest thanks both to the members who are present here to-night, and to those who are absent, for having confirmed that nomination. The honour which you have done me is very great, and I find it impossible adequately to express in words my grateful appreciation of it. I can only say that I accept the position as the highest honour of my professional life. In return I promise that, to the best of my ability, I will so perform my duties that the lustre of this great Institution may not be dimmed, but may if possible be made brighter, and that when I go out of office, its prestige and its usefulness for the advancement of the interests of its members may not be less than I find it.

This is the Mother Institution of the engineering profession. There are other vigorous and strong Institutions specialising in their branches of the profession. I am glad to say that many of their members are also members of our own society, and I trust their love for the parent Institution may never grow cold. It will be my endeavour to cement the goodwill at present existing between all the Institutions and to promote exchange of views which may benefit the profession as a whole. An important step in this direction has already been taken by the establishment of the Engineering Joint Council, the usefulness of which is developing satisfactorily.

I fully realise that the duty I am undertaking will be an exacting one, yet, relying on the support of the council and officers, and upon the generous encouragement of the members, I enter upon my task not without anxiety, but certainly with no misgiving. That task is intimately bound up with the purpose and duty of the Institution itself. The profession of engineering, in common with all other professions, is passing to-day through very troublous times. The young men who now enter it, often with an equipment of scientific knowledge and of general education which would have been regarded as exceptional in the Westminster offices of my own early days, are yet confronted by extraordinary difficulty in obtaining work. It must be discouraging to them sometimes. They must sometimes be tempted to believe that the profession of Civil Engineering has entered upon a permanent decline and that they will never find that outlet for their energy and enterprise which any young man, who has to make his way in the world, is entitled to expect. I believe that all such counsels of despair are false counsels, but that there is at least apparent reason for temporary discouragement no one can deny. If I and my contemporaries, who fought our early battles amid the prosperity and expansion of the 'seventies, were complacently to shut our eyes to the seriousness of the present situation of junior members of the profession, we should be failing in our duty, and, I think, failing also in common sympathy and understanding. It is the part of such an Institution as our own to face the truth squarely and to do all that can be done, by organisation, encouragement and co-operation, to hasten that recovery of the whole profession to which we all look forward.

I have said that, in my opinion, there is no cause to think darkly of the future. In this address upon the prospects of those engaged in or intending to follow the profession of engineering I propose to give you the grounds upon which that opinion is based. But, before I look forward to the days to come, it may, perhaps, not be inappropriate that I should look back to the days that have gone by, so that we may consider the circumstances of the profession more than fifty years ago, and, having in the briefest outline traced certain aspects of its development, pass on to consider the circumstances of to-day and to look forward to those of to-morrow.

I propose, therefore, to give a short account of conditions as I found them in 1870 when I began my pupilage at Westminster. I shall confine myself more particularly to the London area, with which I am most familiar and which may, I think, be taken as being in many important respects typical of other cities throughout the Kingdom and Empire. Now in 1870 there was great activity in the promotion of schemes for new railways by the then existing railway companies, by private companies, and by professional promoters. A professional promoter (now almost squeezed out of existence) was one who, with the aid of a syndicate, promoted Bills in Parliament, and, if successful in obtaining an Act, took the first opportunity to dispose of his powers to one or other of the rival companies in the district to which his powers applied. The committee rooms of the Houses of Parliament were overwhelmingly full of work, and, whether in promotion or opposition, engineers, experienced great pressure of work in committees. This busy atmosphere, so satisfactory to the profession and of such good omen to the country at large, has, I regret to say, almost disappeared, and the older members of the profession, who find themselves nowadays in the corridors and committee rooms, are sometimes a little depressed by their present aspect. It is difficult to imagine, even in normal circumstances, that the bustle and life will ever return again, and it seems less likely than ever now that we have the "Grouping of the Railway Systems," and so many matters previously dealt with in the committee rooms are now settled by the officials of Government departments.

In 1870 the provision for public locomotion in inner London was by rail on the sections of the Metropolitan and District Railways as follows:—

Metropolitan Railway.

Paddington to Farringdon-street	opened 1863
Hammersmith Line	opened 1864
Farringdon-street to Moorgate-street	opened 1865
Baker-street to Swiss Cottage and South Kensington	opened 1868
L.C. & D. Junction to Farringdon-street and Widened Lines to Moorgate-street	opened 1866–68
East London Line, New Cross to Wapping	opened 1869

District Railway.

South Kensington to Westminster and Blackfriars	opened 1868–70
Blackfriars to Mansion House ...	opened 1871

You might travel also by the penny steamboats, though after many vicissitudes they ceased to run; by hansom cabs, four-wheelers, and the horse-drawn omnibuses. Upon an omnibus, if you were athletic enough, it was a privilege to get a box seat next the driver, and not only learn your London, but some of its choicest vocabulary, of the kind known only to the drivers and understood by those with whom they exchanged terms of "endearment" when passing. These means of travel were already beginning to be found inadequate for the needs of an increasing public.

The Great Eastern Railway Company, under the powers of their 1864 Act, were pressing on with the construction of their suburban and metropolitan extensions, including the provision of the City terminus at Liverpool-street, but none of these works was brought into use before 1872. Credit must, however, be given to the Great Eastern Railway Company for being the first company to make special provision for the traffic from the outer suburban area. It was a bold policy, and the building development following the construction of the railways proved it to be a sound one. It formed, indeed, the turning-point in the success of that company.

The Thames Embankment between Blackfriars and Westminster was opened for traffic in 1870. Electric lighting was in its infancy. There was a system of arc lighting installed on the Embankment, but you never knew how long you would be in light or darkness, and the installation was superseded. I well remember an exhibition of electric lighting for domestic purposes held at the Crystal Palace, which was looked upon as a great novelty and created much interest.

As an instance of the pleasures of travel in those days on the Metropolitan Railway, I quote the following from the Memoirs of Sir William Hardman "Through London in the 'Sixties." In 1863, Hardman and his wife braved the adventure of a journey on the Underground, and he wrote: "Yesterday Mary Anne and I made our first trip down the 'Drain.' We walked to the Edgware-road and took first-class tickets for King's Cross (sixpence each). We experienced no disagreeable odour beyond the smell common to tunnels. The carriages hold ten persons, with divided seats, and are lighted by gas (two lights). They are also so lofty that a six-footer may stand erect with his hat on." Many of us can well endorse that record from our own experience, even at a later date. The author does not describe the nature of the "smell common to all tunnels." It is told of the late Thomas Hawksley that, while under cross-examination, he was asked to describe an unpleasant odour which he had detected in a sample of water. He replied "that it was of such a nature that it was quite impossible to measure it by a 2-foot rule," and I expect that there would have been the same difficulty with the "smell common to tunnels" which Sir William Hardman found on the Metropolitan Railway.

If we were constant travellers on the Metropolitan for a certain period, and showed no signs of ill-health, it was good evidence in assisting the doctors in their decision as to whether we were "first-class" lives for insurance purposes or not. The author quoted refers to the railway as the "Drain," some now refer to the tube passengers as "sewer rats," so Sir William Hardman may have foreseen that after the "Drain" the sewer would develop. I wonder what he would think of the excellent conditions of ventilation and lighting existing to-day on the Metropolitan Railway and in the tubes. During the period 1870–90 many extensions of the inner and outer suburban lines were brought into use, including the Inner Circle Line, in 1884, and the pioneer tube, the City and South London Railway (Stockwell to King William-street) in 1890.

We get, then, a jump of 10 years. In 1900 the City and South London line was extended at one end (King William street) to Moorgate-street, and at the other (Stockwell) to Clapham Common, and in the same year the Central London line was opened between the Bank and Shepherd's Bush. I will not follow the rapid developments since 1900, but some of the principal landmarks between 1870 and 1920 may be of interest. I have, therefore, set them out in chronological order, giving the year in which the lines were opened for traffic.

1870–71	Metropolitan District Railway	Westminster to Mansion House.
1872	Great Eastern Railway	Bishopsgate (Low Level) to Bethnal Green, Hackney Downs, Stoke Newington, Edmonton (Silver-street) and to Junction with Enfield Branch.

* Delivered at the Institution, November 6, 1923.

1872	Great Eastern Railway.	Hackney Downs to Clapton and Walthamstow.
1873	Great Eastern Railway.	Walthamstow to Chingford.
1874	Great Eastern Railway.	Bishopsgate to City Terminus at Liverpool street (local passenger trains).
1874	Metropolitan District Railway.	Earl's Court to Hammersmith.
1875	Great Eastern Railway.	Bishopsgate to City Terminus at Liverpool-street (all trains).
N.B.—Bishopsgate (old terminus) last used for passenger traffic, December, 1877.		
1875–6	Metropolitan Railway.	Moorgate to Aldgate.
1876	East London Railway.	Wapping to Shoreditch (New Cross to Wapping, 1869).
1877	Metropolitan District Railway.	Hammersmith to Richmond.
1878	Great Eastern Railway.	Seven Sisters to Palace Gates.
1879	Metropolitan District Railway.	Turnham Green to Ealing Broadway.
1879–80	Metropolitan Railway.	Swiss Cottage to Harrow.
1882	Metropolitan Railway.	Aldgate to Tower.
1883	Metropolitan District Railway.	Acton Town to Hounslow.
1884	East London Railway.	Junction with Metropolitan Railway at Whitechapel.
1884	City Lines and Extensions.	Aldgate to Mansion House and Aldgate East to St. Mary's.
1884	Inner Circle.	
1889	London and South Western Railway.	Putney Bridge to Wimbledon.
1890	City and South London Railway.	Stockwell to King William-street.
1894	Great Eastern Railway.	Widening of Liverpool-street Station and approach lines thereto.
1900	City and South London Railway.	King William-street to Moorgate.
1900	City and South London Railway.	Stockwell to Clapham Common.
1900	Central London Railway.	Shepherd's Bush to Bank.
1901	City and South London Railway.	Moorgate to Angel, Islington.
1902	Whitechapel and Bow Railway.	
1903	Metropolitan District Railway.	South Harrow Line: Hanger Hill Junction and Park Royal.
1904	Great Northern and City Line.	Acquired by Metropolitan Railways 1913.
1904	Metropolitan Railway.	Harrow to Uxbridge.
1905	Electric services commenced on the Metropolitan District and Metropolitan Railways between Baker-street and Uxbridge and also on the Inner Circle Railway.	
1906	Metropolitan Railway Electric Service.	Hammersmith and City Line.
1906	London Electric Railway.	Baker-street to Elephant and Castle.
1906	London Electric Railway.	Hammersmith to Finsbury Park.
1907	London Electric Railway.	Baker-street to Edgware-road.
1907	London Electric Railway.	Holborn to Strand.
1907	London Electric Railway.	Charing Cross to Golder's Green and Highgate.
1907	City and South London Railway.	Angel to Euston.
1909	London, Brighton and South Coast Railway.	Commenced electrical working on suburban lines.
1911	Metropolitan District Railway.	First escalator installed at Earl's Court Station.
1912	Central London Railway.	Bank to Liverpool-street.
1913	East London Railway.	Electrified.
1913	London Electric Railway.	Edgware-road to Paddington.
1914	London Electric Railway.	Charing Cross (Strand) to Charing Cross Embankment.
1914	London and North Western Railway.	Electrical working started to and from Earl's Court.
1915	London and South Western Railway.	Electrical working started Waterloo to Wimbledon *via* East Putney.
1915	London Electric Railway.	Paddington to Queen's Park.
1916	London and South Western Railway.	Electrical working started Waterloo to Hounslow.
1920	Central London Railway.	Ealing extension line.

OMNIBUSES.

1897	First motor 'bus licensed in London, working between Charing Cross and Victoria.
1904	Motor 'buses brought into regular working by the London Road Car Company, and replacement of horse 'buses commenced.
1911	Last horse 'bus publicly plying for passengers withdrawn.
1920	"K" type omnibuses, seating 46, introduced to replace "B" type, seating 34.
1921	"S" type omnibus, seating 54.

TRAMWAYS.

1870	First Tramways Act for London passed.
1871	First authorised tramway commenced operating in London.
1901	First electric tram running in London (London United Tramways Service).

It is not claimed that the foregoing tables disclose a complete position, but they are sufficiently comprehensive to show how, since 1870, developments have been made to meet the increasing requirements of the public. There have been, too, very important changes within the Greater London area in the approach lines of all the main lines of railways. These have been greatly improved by widenings, additional stations, and by other means. The following tables deal with Greater London.

POPULATION OF GREATER LONDON.

Year.	Number.	
1870	3,813,632	
1880	4,670,243	increase over 1870 22·46 per cent.
1890	5,540,430	increase over 1870 45·28 per cent.
1900	6,484,516	increase over 1870 70·03 per cent.
1910	7,181,415	increase over 1870 88·31 per cent.
1920	7,460,000	increase over 1870 95·61 per cent.

Local railways, in the next table, comprise the Metropolitan (including Great Northern and City), Metropolitan District, London Electric, City and South London, City Lines, Extension, Whitechapel and Bow, East London, Waterloo and City.

Prior to 1910 the figures for omnibuses are in respect of London General Omnibus and Road Car Companies only—other figures prior to 1910 are not available.

Motor-omnibuses have increased in 1922 by about 15 per cent. over 1920. Taxi-cabs have increased in 1922 by about 19 per cent. over 1920.

Route Miles of Local Railways in Greater London.

Year.	Miles.
1870	22
1880	31
1890	50
1900	74
1910	103
1920	108

In the above figures only that portion of the Metropolitan Railway which is within the Metropolitan Police area is included. In all other cases it is the total length owned.

Number of Local Passenger Stations Open for Traffic.

Year.	No.
1870	33*
1880	51*
1890	63*
1900	99
1910	168
1920	174

* Estimated, but believed to be correct.

Route-Miles of Tramways in Greater London.

Year.	Horse Traction Miles.	Electric Traction Miles.	Total Miles.
1870	Nil	Nil	Nil
1880	65	..	65
1890	129	..	129
1900	139	..	139
1910	*	*	333
1920	Nil	350	350

* No separate figures available.

NUMBER OF PASSENGERS CARRIED.

Year.	Local Railways.	Suburban Sections of Main-Line Railways.	Tramways.	Omnibuses.	Total.
1870	60,000,000	Not available	†	42,935,471	—
1880	99,000,000		64,817,361	57,722,231	—
1890	148,600,000		191,041,904	148,531,099	—
1900	194,100,000	238,000,000*	340,203,066	264,503,868	1,036,806,934
1910	416,859,177	281,000,000	763,797,856	377,207,555	1,838,864,588
1920	722,586,489	401,000,000	1,065,788,631	935,946,002	3,125,321,122

* Commencing 1902. † First regular tramway service commenced in London in 1871.

Figures for all traffic for 1922 as against 1920 show a falling off of	Passengers. 155,569,386
Omnibus traffic shows an increase of...	57,863,588
Local railways decrease	130,820,998
Main Line Suburban decrease ...	53,000,000
Tramways decrease	29,611,976
	213,432,974
Less increase omnibus	57,863,588
Total falling off	155,569,386

It will be seen from the figures that the increase in number of passengers carried in 1920 on

Local railways over that of 1870 is equal to 1,104·3 per cent.

Suburban lines over that of 1902 is equal to 68·5 per cent.

Tramways over that of 1880 is equal to 1,544·3 per cent.

Omnibuses over that of 1870 is equal to 2,080·0 per cent.

The total 1922 figures show a falling off of 5 per cent. from the 1920 figures after allowing for an increase of 6 per cent. in the omnibus numbers.

Journeys per head of Population.

Year.	Local Railways.	Suburban Sections of Main Line Railways.	Total Railways.	Tramways. ways.	Omnibuses.	Total.
1870	16	Not available	..	..	11	..
1880	28		..	14	12	..
1890	30		..	34	27	..
1900	33	29	62	52	41	159
1910	59	34	93	106	53	256
1920	93	49	142	143	125	418

The result is an increase of journeys per head in 1920 over that of 1900 as follows:—

	Per cent.
Railways...	129
Tramways	175
Omnibuses	205

Number of Omnibuses Licensed by the Metropolitan Police.

Year.	Horse Omnibus.	Motor Omnibus.	Total.	Hansom Cabs.	Four-Wheelers.	Taxi Cabs.	Total Vehicles.
1870	1,268	..	1,268	4,891*	2,450	..	8,609
1882	1,389	..	1,389	6,269	3,713	..	11,371
1892	2,305	..	2,305	7,133	3,679	..	13,117
1900	3,681	4	3,685	7,531	3,721	..	14,937
1910	1,103	1,200	2,303	2,003	2,721	6,397	13,424
1920	..	3,365	3,365	34	487	6,025	9,911

NOTE.—There is no means of ascertaining what proportion of most of these vehicles operated in the London area.

* No subdivision between hansoms and four-wheelers available for 1870. The figures are therefore in that respect estimated.

The foregoing returns give some idea of the passenger-traffic developments in the period under review, but in dealing with the number of licensed road-vehicles, and the additional rail-facilities referred to, the advantages that have accrued by additional carrying-capacity and speed must be allowed for, to arrive at anything like a true measure of the increased facilities.

In 1870 the working of 20 trains per hour on the Metropolitan Railway was considered good, whereas to-day on certain sections the number has doubled, this being possible principally owing to electric traction and automatic signalling.

One of our motor-buses to-day, for the reasons stated, provides for the public requirements equal on a safe estimate to about six of the old horse 'buses.

The few figures I have quoted deal only with public vehicular passenger traffic and, therefore, do not touch more than the fringe of the problem of road congestion. When we consider, in addition to this, the enormous increase of road traffic resulting from the general development of our trade, not only in factories and business premises but in the docks, and by the riverside, it is clear that the problem is even more urgent than my figures, taken alone, would suggest. A single instance of the increased use of the roads is the great growth of road transport from dock to wholesale merchant, and from merchant to retailer. Vehicles engaged in this traffic, which obstruct the roadways in the process of loading and discharging, are among the most serious causes of the present unsatisfactory condition. Another cause is that the hours of work are less spread than formerly, there being a nearer approximation to a common time for the beginning and ending of work. This concentrates the "peak load" of all means of transport upon shorter periods. A further cause, and a fast-growing one, is the increasing density of the business population. When old premises are rebuilt, the new premises have in some cases new floor-space below and above pavement-level, and give more than double the area of the buildings displaced. Thus, "peak traffic" is given additional local concentration and further road-congestion inevitably results.

That, in rough outline, is the nature of the problem as I see it. I shall not attempt here to make detailed suggestions for solving that problem. It is a very serious, very urgent, and becomes more urgent every day. Whatever the solution may be, it will bring work to engineers. Developments of engineering have created the problem; further developments will solve it.

Everywhere the same story of developments which will insist upon further development is repeated. Our great municipal authorities have carried out works of street improvements, great works of sewerage, and have been very active in all matters affecting the public health. There is at the present time great activity in the construction of arterial roadways, so as to admit all classes of fast motor traffic. I venture to hope that some special provision will be made for direct levy on the users of these roads; otherwise there will be an unfair burden (even if the first cost is otherwise provided for) upon the ratepayers. Upkeep and reconstruction is a very serious expense on present roads, a much more

serious one on these arterial roads, where the traffic will be heavy and the speed will undoubtedly be high.

The construction of new docks and waterside premises, and the improvement of those existing, notably in their equipment with modern mechanical appliances to facilitate the expeditious clearance of ships, is also to be noted. There are, too, new and improved water supplies and storage reservoirs; great advances in connection with mining, smelting furnaces, ironworks, and the chemical industries; and there have been vast changes in the mechanical means of transport, by land, by water, and in the air. The submarine and the aeroplane; wireless telephony and telegraphy; and even the development of electricity in its application to power—all these things are yet in the early stages of their history. We have gone far, but we have much farther to go. Without electricity the present efficiency of the Metropolitan Railway could not have been attained, and the working of our "tube system" of railways would have been impossible.

It has enabled the carrying capacity of the suburban railways in London and other great cities, where stops are frequent, to be increased by reason of its efficiency in acceleration and deceleration, and it is a great time-saver at terminal stations. It would, however, be wrong to assume that it is equally applicable and profitable where the peculiar circumstances of suburban traffic do not exist.

Remembering the high efficiency of the present steam locomotives, and their elasticity under load, I view with very considerable doubt the desirability as a commercial proposition of the application of electric traction to main-line traffic. Whatever may be the future of electric traction on the railways in this country, it appears to me—apart from all other considerations—to be most necessary that a common system should be standardised, so as to allow of free and complete interchangeability of rolling stock over the lines of the various railway companies. We have had experience in the past of the hampering of trade by differences in gauge. Let this lesson be our warning not to make any analogous error in our electrical systems. Circumstances might easily arise now that we are no longer a "tight little island" where any obstacle in the free interchangeability of traffic might be fraught with great danger.

I have now set out in a very sketchy way some of the expansion that has occurred within my own professional life. All of it has brought work to engineers in particular, and to men engaged in kindred professions. Many things which to-day seem almost commonplace and part of our daily life, were not anticipated or even thought of in 1870, but if we go a little farther back to the beginning of the nineteenth century, the advance has been proportionately even more remarkable. I quote from a book, "The Revolt against Civilisation," by Lothrop Stoddard, which may give us all reason to look back and also to examine the present. Mr. Stoddard writes:—

"Our civilisation may be inferior to others in some respects. It may lack the beauty of the Greek, the durability of the Chinese, the spirituality of the Mediæval. But in dynamic energy, in mastery over the forces of nature, and in all-round efficiency it far transcends anything the world has ever seen.

"In fact within the past century (speaking of the nineteenth century) we have broken the age-old tempo of material progress, and have leaped clear over a new self-made world. Down to a trifle over a century ago, man's material progress had been a gradual—a very gradual—evolution. His tools, though more numerous, were mainly elaborations of those discovered by his remote ancestors. A few instruments like the printing press and the mariner's compass were about the only notable innovations. Man's control over natural resources had likewise not greatly expanded. With the exception of gunpowder, he had tapped no new sources of material energy since very ancient times. His chief source of power was muscle, animal and human (do we not still reckon in 'horse-power'?), and, for the rest, he filled his sails with the breeze and turned clumsy waterwheels by using brooks and streams. But the ancients had done all these things. As for methods of communication, they had, if anything, deteriorated. In the year 1800 there was no system of highways which equalled the Roman roads, no posting service as quick as Cæsar's, no method of signalling which could compare with the semaphore 'telegraphy' of the Persians, and probably no ship which could not have been overhauled by a Phœnician galley in a moderate sea.

"Suddenly, astoundingly, all was changed. The hidden forces of nature yielded themselves wholesale as though at the wave of a magician's wand, steam, electricity, petrol, and a whole series of mysterious 'rays' and 'waves' gave man powers of which he had not even dreamed. These powers were promptly harnessed to innumerable machines which soon transferred every phase of human existence. Production and transportation were alike revolutionised, distance was well-nigh abolished, and the very planet shrunk to the measure of human hands. In other words, man suddenly entered a new material world, differing not merely in degree, but in kind, from that of his grandfathers.

"Now all this inspired modern man with that spirit of confidence and optimistic hope in an illimitably glorious future which characterised the greater part of the nineteenth century."

The quotation given sums up in general terms very shortly the position at which we have arrived; but are we to stop there, or are we to maintain our hope of the future? What lies ahead for the community in general and for our profession in particular? The answer, I think, lies in the fact that science creates a need for science. It solves one problem only to create another which it solves in its turn. Steam transport came as an answer to the industrial revolution at the end of the eighteenth and the beginning of the nineteenth century; it linked town with country; it multiplied opportunities for human activity, and, in consequence, it increased population. It brought that population to the towns. Mr. Fletcher, in the fourth volume of his "History of England," tells us that "in 1801 there were 152 and in 1901 there were 558 persons per square mile in England and Wales. The total population was nearly quadrupled during the nineteenth century. The proportion of those living in towns to those in the country was almost exactly equal in 1851. In 1901, 75 per cent. of the total lived in towns." Road congestion, to which I have already alluded, is but an example of the problems created by this change, which it will, in the future, be the duty and privilege of engineers to solve.

Moreover, work will come from two never-failing sources—from the obsolescence and supersession of existing work and from entirely new inventions. There is now and must always be, continuous scrapping and renewal. As an illustration of recent work of this character, take the City and South London Railway. This was constructed in 1890 and some of it so late as 1907. It is now being reconstructed so that full-size tube stock may work over it. Take again, Liverpool Street Station (G.E.R.), which was an entirely new terminus erected in 1874. In 1894, after an interval of only twenty years, it was considerably enlarged and additional approach lines were constructed, and both Victoria (L.B. and S.C.R.) and Waterloo (L. and S.W.R.), which were reconstructed comparatively recently, are already working at their full capacity during crush hours. We have had a like experience in harbours and docks and in all public utility undertakings. All such work of reconstruction is continuous. In most cases it is more difficult to carry out than original work, because provision has to be made for the continuation in use of the existing undertakings, and there is the greatest need for highly-skilled engineers.

As regards new inventions of a sort which give a fresh impetus to the whole profession, it may not be our good fortune in the immediate future to have some great new discovery which, like the application of steam to power, will open a new era for engineers. We do not know. It may happen. If not, we are still left with sufficient cause for hope. The Victorian era has created more problems than it has solved. There is no sort of finality in the past; no reason to anticipate stagnation in the future. During the nineteenth century discovery and development came so fast that they have resulted in overcrowding, often in confusion. It is our present task to unravel the tangle. We have social, political, and imperial problems of a type and magnitude that were undreamed of fifty years ago. The task of the nineteenth century was to enlarge, to expand, to grasp at each new source of power and develop it, sometimes without full thought of social consequences, to its fullest extent. The task of the twentieth century is to bring back to life some of that order and leisure and spaciousness which was submerged in the too hasty tide of Victorian prosperity. Engineers who, if I may say so, were largely responsible for the prosperity, will be called upon in the future to undertake the great task of simplification and organisation and reconstruction, without which that prosperity cannot bear its fullest and best fruit.

I see no reasonable limitation to further advance and progress. Many of the great discoveries and their application to our use are in their infancy. To enable the best use to be made of our knowledge of to-day, we have almost every conceivable opportunity in our vastly improved educational advantages. Consider, for instance, the immense possibilities opened up by a special training at the National Physical Laboratory. The many means available to all classes of a technical and theoretical education at our universities and at the numerous technical colleges in most of our large manufacturing centres were practically non-existent fifty years ago. With all of these advantages the young engineer of to-day starts, or has the opportunity of starting, having first studied the profession of engineering in all its branches.

Assuming that he has up to this stage made the fullest use of his exceptional opportunities, the battle for success and a useful career only begins. The necessity still remains for consistent and continuous hard work to obtain knowledge of the practical side of his profession, and the proper application of his theoretical and scientific education to it. The combination of the two is absolutely essential. The young engineer has also to remember that, as he will generally be acting in a position of trust and responsibility, the possession of a character for strict rectitude and fairness is indispensable to success. I believe, notwithstanding the present obscure outlook, and the abnormally depressing times engineers have recently been through, brought about principally as an aftermath of the Great War, that the prospects of work for the profession in all its many spheres of activity are full of hope and promise. In addition to new developments, we have large works of reconstruction going on to meet the pressing demands of the present, and if we bear in mind the enormous advances of unthought-of works made in my time, which I have so imperfectly reviewed, we have, I think, a right to believe that a bright and successful career is awaiting the profession, particularly those members of it who are fully equipped in character and training, and are hard workers.

WATER TROUBLES IN THE CUSHING OIL FIELD.—In the famous Cushing oil field in Oklahoma water has obtained access to a number of the producing wells, and the situation has developed so seriously that an engineering investigation has been instituted to frame remedial measures.

DEVELOPMENT OF SHIPS' STRUCTURAL DESIGN.*

By H. W. CURCHIN.

IN presenting this paper, I do not propose to give an historical *resumé* of the progress of shipbuilding, nor do I intend to enter into abstruse scientific details which in many respects are entirely matters of opinion, and difficult if not impossible, to prove; but rather to summarise the steps of progress from the inception of iron ship construction to the present day, hoping that the views set forth may lead to valuable discussion and further profitable development of the important industry in which we have the privilege to be engaged.

The great importance of scientific investigation into structural design in its relation to commercial shipowning cannot be overestimated. It results in cheaper production due to reduced weight of material, with a corresponding increase in deadweight, reduced fuel consumption or greater speed, and improved hull efficiency. The effects are far-reaching, inasmuch as they are reflected in lower transport costs, and consequently commodities from the Colonies and foreign countries are cheaper to the consumer.

Whilst it is highly desirable that weight of steel and cost of construction be reduced, it is of equal or greater importance that the structure be strong enough to carry out the work it is called upon to do satisfactorily and efficiently. The cost of repairs, expense incidental to delays, increased insurance premiums, &c., due to insufficient structural strength, will quickly counterbalance any apparent advantage following a reduction in the weight of steel. Sound commercial design, again, is not represented by a suitable margin of initial strength only. The question of upkeep and life in a structure subject to severe corrosive action is of paramount importance.

I propose to show in the following diagrams structural midship sections illustrating in a general way the modifications that have taken place in design. In view of my opening remarks, I must apologise for presenting to you a section of a typical wooden ship (Fig. 1 on the next page). This is, however, necessary, as I find it undoubtedly represents the basis of the present day transverse ship—transverse timbers or frames, floors, beams and pillars, together with the longitudinal material, consisting of keel, planking and ceiling, decks, keelsons, clamps, &c. It is, I think, obvious that this design represents the maximum efficiency obtainable from the material used in the construction. No doubt the tiers of beams shown on the plan were necessary to ensure ample transverse strength in order efficiently to develop and support the longitudinal material. It must be remembered that we are here dealing with sailing ships subject to transverse stresses due to the action of the wind on the sails. When at sea they were practically always at an angle of heel, held there for comparatively long periods by the force of the wind, subjecting the structure to stresses in a transverse direction, and tending to deformation. Dimensions were limited by questions of strength, which it would appear to be impossible to provide commercially in ships of considerable size.

When iron was introduced, it was probably natural that the same system of construction should form the basis of design; Fig. 2 illustrates clearly the similarity. As the planking and ceiling, decks, &c., provided the longitudinal strength in a wooden ship, and were necessarily supported at close intervals, because of the nature of the material, so the shell plating, decks, &c., provide the longitudinal strength in an iron ship, also supported at comparatively close intervals by transverse members. It will be observed that in the iron ship the lower tiers of beams are still retained, probably because most of the ships built at the period were sailing ships.

I am not sure that even this reason is justifiable, because during the war I refitted an old barque which had been dismantled and used as a coal hulk, in which a very considerable number of the original hold beams had been cut away. Instead of replacing them I persuaded the owners to agree to their omission. In order to provide the necessary support to the frames I ran a stringer of sufficient strength between the remaining beams. She afterwards ran many trips fully laden without any sign of straining. I mention this because it is an indication of the fact that even under sailing ship conditions, an extra tier of hold beams was not apparently absolutely necessary for strength purposes in an iron ship.

We now come to the introduction of the double bottom. Fig. 3 shows the MacIntyre bottom with girders in a longitudinal direction on the top of the ordinary floors. Hold beams are still retained. Particular attention is drawn to the fact that the girders are spaced 3 ft. apart, without any transverse support to the tank-top plating other than the tank ends.

Next we have the cellular double bottom shown in Fig. 4, which is the principle of the present bottom construction. Hold beams are still a feature of the design. The superfluity of hold beams for structural strength at this stage apparently occurred to ship designers and classification societies, although it is probable that the obstruction to cargo was primarily responsible for their omission. To compensate for the omission of the hold beams, web frames and side stringers were introduced (see Fig. 5), resulting in a wonderful and fearful structure, in which it is difficult to determine whether the stringers support the webs, or the webs the stringers.

The elimination of web frames and the substitution of what was known as the deep frame, was the next step, but deep hold stringers of modified design were retained (see Fig. 6). Of all the steps in the elimination of

* Paper read at the North-East Coast Institution of Engineers and Shipbuilders, in Newcastle-on-Tyne, November 2, 1923.

structural members, and the substitution or modification of others, this is probably the most glaring instance of the absence of even the most elementary scientific investigation. Fortunately, this most unscientific and uneconomical design did not have a long reign, and was followed by the light intercostal stringer, the function of which was, I believe, to afford support to the frame members against tripping (see Fig. 7).

At this stage, the well-known longitudinal system invented by J. W. Isherwood (Fig. 8) came into being. Here the closely spaced transverse members which had been the vogue from the days of wooden shipbuilding were superseded by widely spaced strong transverse members in conjunction with lighter longitudinal members fitted to the bottom, sides and decks, in order to support the plating, and to increase the area of longitudinal material. This alteration in design provided a structure of increased longitudinal strength, with a substantial saving in the weight of material.

Due undoubtedly to the design of the double bottom construction in the Isherwood ship, a similar method was introduced in the transversely-framed vessel, but with the members turned through an angle of 90 deg. This construction is one of the standard requirements of the classification societies to-day for transverse ships (see Fig. 9).

We now come to the system in which the bottom and top sides are framed longitudinally, whilst the sides are supported with vertical framing; this is known as the Millar system (see Fig. 10). I am afraid that the only conclusion to be arrived at, following a general survey of ship structures, indicated by the earlier designs illustrated, is that scientific investigation did not play a leading part in their development, as the principle of steel construction is the same to-day as at the time when iron replaced wood, with the exception of the Isherwood and Millar systems. There has been a continuous elimination of superfluous members, but this has been due rather to commercial pressure than to scientific investigation. I therefore propose to place before you some of the conclusions I have arrived at by direct observation and investigation into the technical and practical phases of ship structure, following a number of years' experience of transverse and longitudinal construction of ships. My views are based upon experience not only in design, but with practical building and close investigation of structural damage and repairs.

Before dealing with the question of theoretical strength, I would particularly point out that the figures are used comparatively. Further than this, I would emphasise the fact that in the ordinary standard Section Modulus calculation, it is assumed that all the material taken into the calculation is developed. This point is of the greatest importance, and will be dealt with in the course of my remarks.

A ship's structure is subject to longitudinal, transverse, torsional and local strains, some of which are calculable up to a point, others of which are not. As the longitudinal strains are undoubtedly the greatest to which the hull structure is subjected, I propose to deal with this aspect of the question most fully. In the ordinary or standard type of transversely framed ship, the longitudinal material consists of keel, bottom shell, tank top, centre girder, side girders, and tank margin, forming the lower member; the deck stringers and deck plating the upper member, the side plating forming the web of the girder as a whole. Before dealing with the complete structure, I suggest that we can with advantage consider separately the various parts comprised in the whole.

I think that the plating of the lower and upper members of the girder must in sectional detail be part of individual longitudinal members or girders, and fully developed in order efficiently to carry out their function in the complete hull. For instance, the centre girder forms the web of a girder, the upper and lower members of which are the keel and part of the shell, and the tank top respectively. Again, the side girders and tank margin form the webs of similar members. The amount of flange material each web member develops in a complete efficient girder depends upon the thickness of the flange material—or what amounts to the same thing, the support afforded by the transverse members—and varies directly with the stiffness, and inversely with the elasticity of such members. For instance, a longitudinal girder consisting of a side or centre girder can presumably develop a greater width of plating in the upper and lower members if supported by solid floors, say 2 ft. apart, than it would without such supports, as the extent of the developed plating depends upon the rigidity or flexibility of the supporting members. Fig. 11 illustrates the point I wish to make. This shows three girders, in one of which the flanges are supported by plate brackets; in the second by angle supports; and entirely unsupported in the third. It is obvious that more flange material is developed in Fig. A than in Fig. B, and in Fig. B than in Fig. C.

Instead of the support afforded by the transverse stiffening members, we may increase the thickness of the flanges of the girder, but it is recognised that this arrangement is commercially unsound.

As in individual members of the hull structure, so in the complete girder. We have the bottom and tank-top plating and stiffening members consisting of the floors or skeleton floors, and the deck plating, also with its stiffening members consisting of the beams, supported and tied together by the vertical web formed by the side plating and pillaring arrangements. As with the individual girders, so with the complete structure. The webs develop only that portion of the material in the flanges in the vicinity of the webs that will stand up rigidly to its work. If the stiffening of the plating, however constituted, either by sectional material or increased thickness, is not efficient over the full width of the flange, the total sectional area does not provide its full quota of longitudinal strength.

In the same way, if the vertical webs are not of sufficient stiffness to provide ample support to the flange members, but have a tendency to deflect or buckle under strain, then the material in the flange members is not developed to its full capacity. Fig. 12 showing simple forms of girder construction, and familiar to all of us, illustrates the point admirably.

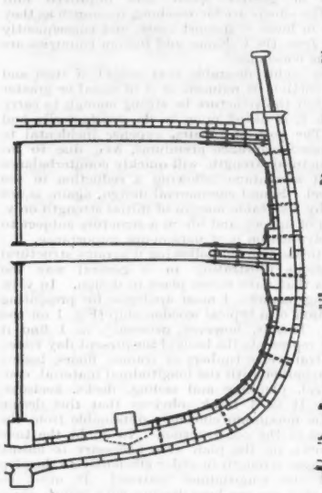


FIG. 1. TYPICAL WOODEN SHIP.

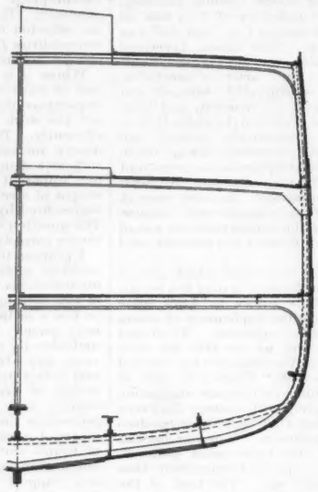


FIG. 2. IRON SHIP, SINGLE BOTTOM, TWO OR THREE TIERS OF BEAMS.

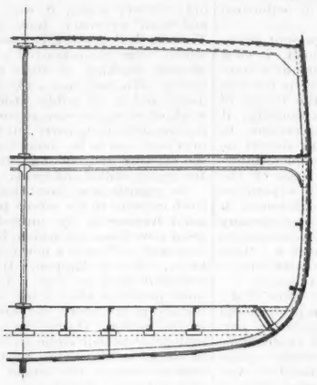


FIG. 3. IRON SHIP, MACINTYRE DOUBLE BOTTOM, TWO TIERS OF BEAMS.

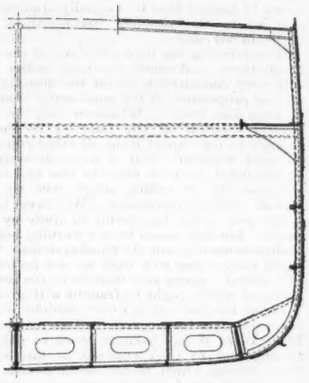


FIG. 4. IRON SHIP, CELLULAR DOUBLE BOTTOM, TWO TIERS OF BEAMS.

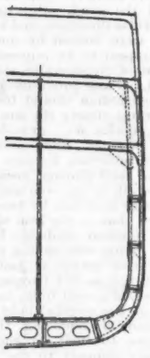


FIG. 5. IRON SHIP, WEB FRAME.

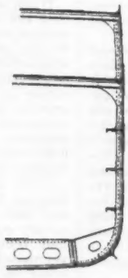


FIG. 6. IRON SHIP, DEEP FRAMES AND DEEP STRINGERS.

FIG. 7. IRON SHIP, DEEP FRAMES AND SHALLOW STRINGERS.

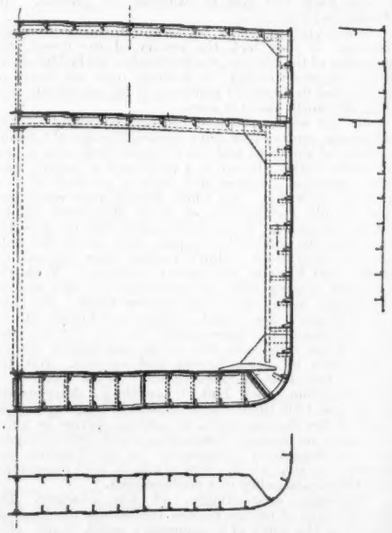


FIG. 8. IRON SHIP, LONGITUDINAL FRAMING, ISHERWOOD SYSTEM.

Fig. A is a single section girder or joist, the flanges in proportion to the depth. Figs. B and C show the methods adopted to ensure development of the webs and flanges when the depth or width becomes greater. The method of supporting the webs is important to ensure the development of the flanges. The principal feature of such structural girders is that the width of the flanges is proportional to the thickness, and takes account of the quality of the support.

I wish to emphasise the importance of ensuring the development of material taken into account in an $\frac{I}{Y}$ calculation. For instance, we take a ship with transverse frames spaced 24 in. apart, the shell being 0·50 thick. If the spacing is increased to 30 in., the shell now being 0·56 and the deck, &c., correspondingly increased, the geometrical $\frac{I}{Y}$ will be considerably greater, but it would

be wrong to assume that the longitudinal strength has been increased to that extent, or even that it had been increased at all. The question also arises in connection with the spacing of solid floors and girders in the double bottom. I have no hesitation in saying that the shell and tank-top plating is not so efficiently developed with widely spaced floors and flexible intermediate members, as it is with solid floors on every frame. I also venture to state that it is better developed with two side girders than with one, although the $\frac{I}{Y}$ calculation would be practically the same in all cases.

In a ship framed transversely in accordance with the present-day established practice, I think it will be agreed that the fundamental principles of economical girder construction are not carried out. What do we find? First of all, in a typical ship of, say, 400 ft. by 54 ft. by 37 ft., having one row of pillars, we have web members 37 ft. deep. The two side ones may be considered efficient, the third one, the centre row of pillars, most decidedly not so, but is taken into account, and assumed to support and develop flanges each about 18 ft. wide. With solid floors on every frame supporting the bottom shell and tank top plating, we may assume that a large proportion of the plating comes into action, and may be taken account of in the longitudinal strength calculation, but when we look at the top flange it would require a wide stretch of imagination to agree to the assumption that anything approaching the full sectional area is developed. With girders in the double bottom 11 ft. 6 in. apart, in conjunction with solid floors 7 ft. 10½ in. apart, and intermediate members of non-rigid or flexible construction, it is impossible to argue that the whole of the bottom and tank-top plating should enter into the calculation.

Figs. 13 and 14 show sections of transversely framed ships. Fig. 13 has two side girders in the double bottom, in conjunction with solid floors on every frame. Fig. 14 shows one side girder with solid floors on every third frame, and skeleton floors between. The thick lines indicate in a diagrammatic manner the comparative amount of material which I suggest is developed in each case to resist longitudinal bending stresses. Assuming the recognised theories applicable to girder construction to hold good—and I see no reason to doubt it—it is clear that the construction shown on Fig. 13 is more efficient than in Fig. 14.

As, however, the system of construction shown in Fig. 14 represents the standard adopted by the eminent classification societies, following the known results of actual experience, it may be taken that the proportion of material efficiently developed is sufficient to provide the strength required successfully to resist the strains brought to bear upon the ship. This being so, and the conclusion being forced upon us that there is a large proportion of longitudinal material undeveloped, it follows that the bending moments resulting from the ordinary standard calculations are very, very seldom, if ever, experienced by a vessel in actual commission. The gradual elimination of members which in many cases provided structural strength, suggest that this is no new thought. In the usual bending-moment calculation, we assume conditions that a ship probably experiences a negligible number of times in her life, and even these conditions are momentary, although the calculation assumes that they are static. Again, I suggest that water has a cushioning effect, and that the strains to which the structure as a complete girder is subjected are transmitted infinitely gradually, and not at all in the severe manner that the bending-moment calculation would equally well apply to.

If the whole of the material could be brought into play, the strength would then be in excess of the requirements, assuming that the classification standard is ample. Pursuing this line of argument, it follows that less material would meet the requirements if efficiently disposed and supported. As I have previously remarked, the technical side of ship construction is intimately associated with commercial shipowning, and a reduction in weight of material, giving increased deadweight and reduced first cost, or advantages in other directions, is of primary importance.

I have also remarked that in addition to questions of strength, that of wear and tear must be considered. A small ship requiring for purposes of strength only light plating, requires for wear and tear purposes material much heavier. There is, of course, a point at which the transference from strength to wear and tear, or wear and tear to strength, takes place. It is in the case of larger vessels where strength is the factor that determines the scantling that it is of vital importance to the shipowner to know that the material is disposed so as to ensure in the most scientific manner its full development in order to obtain a ship structure representing the highest commercial efficiency.

It was with this object in view that the well-known Isherwood longitudinal system was designed. Here we have longitudinal members at close intervals, supporting and developing the bottom shell plating and decks to resist longitudinal bending, and in turn supported at suitable intervals by transverse members. Compared with the standard of transverse construction in vogue at the time of the inception of the Isherwood ship, the reduction in weight due to its adoption was considerable, and represented about 10 per cent. of steel. The transverse construction has been so modified in recent years that this saving in weight is reduced to probably 3 per cent. or 4 per cent., although, and this is of the greatest importance, the theoretical strength is 12 per cent. to 16 per cent. greater in the Isherwood ship. The reduction in weight of the transverse ship is due partly to design, based directly upon the Isherwood plan, as instanced by the double-bottom construction, which today is purely a copy turned through an angle of 90 deg., and also to the direct elimination and increased spacing of members.

In addition to the disposition of longitudinal sectional material on the bottom and top members, the side or web members of the Isherwood ship are similarly framed. Now it is a moot point whether this is a correct system of stiffening the web members of the girder or not. It is true that there are strong vertical frames at intervals varying from about 10 ft. to 12 ft. apart, but it is doubtful whether the full value of the side plating to resist buckling or deflection and provide efficient support for the flange members is obtained with this combination. In addition to this doubtful scientific point, there was always the admitted disadvantage of the projection into the holds of the strong transverses, and the shelves formed by the longitudinals.

Having these points in mind, Mr. William Millar invented the system of framing known as the Millar system. Here we find the top and bottom flanges supported by a number of closely spaced longitudinal members, whilst the sides are stiffened and supported by vertical members. Developing the examination we have given to the pure transverse and the pure longitudinal systems, we find that in the Millar system the technical and practical disadvantages of both are eliminated. The plating of the flange members is efficiently supported and stiffened with the closely-spaced

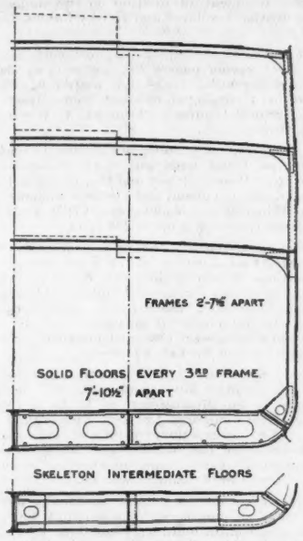


FIG. 9. IRON SHIP, TRANSVERSE SKELETON FLOORS.

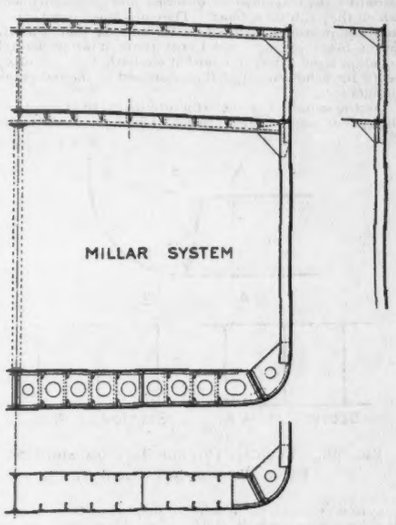


FIG. 10. IRON SHIP, MILLAR SYSTEM.

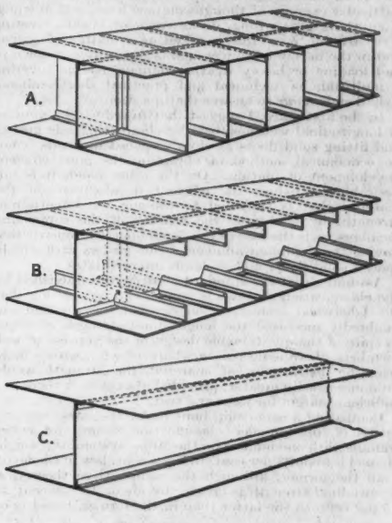


FIG. 11 (A, B, C). SECTIONS OF DOUBLE BOTTOM GIRDERS.

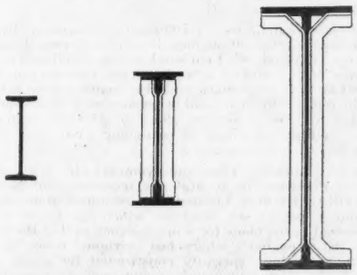


FIG. 12 (A, B, C). SECTIONS OF TYPICAL STRUCTURAL GIRDERS.

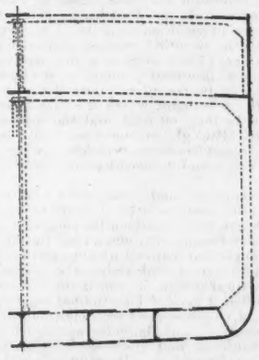


FIG. 13. SECTION OF TRANSVERSE SHIP SHOWING MATERIAL DEVELOPED, 1921–2 RULES.

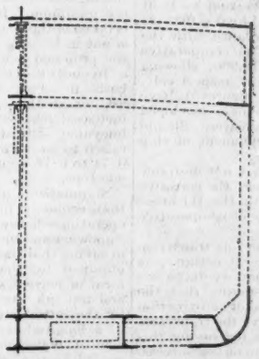


FIG. 14. SECTION OF TRANSVERSE SHIP SHOWING MATERIAL DEVELOPED, 1922–3 RULES.

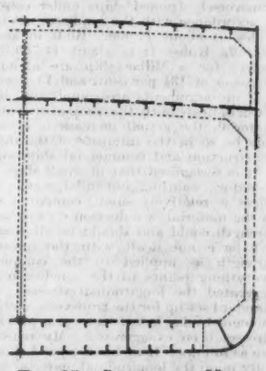


FIG. 15. SECTION OF MILLAR SHIP SHOWING MATERIAL DEVELOPED, 1922–3 RULES.

longitudinals, and the web members are efficiently supported and stiffened with the vertical members, ensuring great resistance to deflection or buckling, and consequently the development of the strength of the flanges to the maximum degree. I do not think these points call for further elaboration, and I suggest they are obvious.

Fig. 15 shows a section of a Millar ship having one plate girder in the double bottom as required by the classification societies, and longitudinal sectional material at the bottom shell, tank top and decks. The thickened lines indicate the extent of the longitudinal material which one can with good reason claim, is developed and comes into active operation in resisting longitudinal bending. The comparison between this section and those shown on Figs. 13 and 14 is interesting. In addition, however, to these structural advantages, the hold spaces are clear of all obstructions, and similar in practically every respect to those in a vessel framed transversely.

It will be asked what advantage is to be derived from a departure from the transverse construction, which we have adopted for years and years, which is well known to the men, entails no new problems, and calls for no particular exercise of thought on new lines, and in which if anything goes wrong, decks crack or buckle, riveting gives trouble, &c.—this is taken as a matter of course, and in the nature of things, and is generally put down to bad loading or heavy weather damage (terms covering a multitude of technical and practical shortcomings). I shall endeavour to answer that question.

In the first place, I suggest that to reduce the number of longitudinal web members by eliminating side girders and fitting solid floors at closely spaced intervals is not an economical method of obtaining the most efficient development of plating. On the other hand, it is not desirable to reduce the efficient development of the material that is supposed to provide the longitudinal strength, by modifying the rigidity of the supporting members, as is the case in the double-bottom construction having the minimum number of side girders with widely spaced solid floors and skeleton intermediates.

Assuming that the standard of strength established by the classification societies is ample, and recognising that the Isherwood system of longitudinal framing had undoubtedly increased the longitudinal strength of ships, in spite of the questionable design of the vertical or web members, there is no reason whatever why, with a more scientific distribution of material, the strength would be unnecessarily greater, provided always that there is a sufficient margin for wear and tear.

Comparing a cargo ship built under the latest requirements of our premier classification society for entire framing with one built upon the Millar system, the weight of steel is about 3 per cent. to 4 per cent. less in the latter than the former, although the comparative theoretical longitudinal strength is greater by about 13 per cent. to 15 per cent. in the latter than in the former, based upon the usual $\frac{I}{Y}$ calculation, in which all the longitudinal material developed or undeveloped is taken into consideration. The section modulus thus calculated of the transversely framed ships under consideration as built in accordance with the requirements of Lloyd's 1922–23 Rules, is about 14,900. Built in accordance with the 1921–22 Rules, it is about 14,700. The comparative figures for a Millar ship are about 16,900, showing increases of 13½ per cent. and 15 per cent. respectively.

If my arguments are sound, and the figures I have given indicate fairly the comparative amount of developed material, the actual increase is even greater. Should this be so in the interests of the development of ship construction and commercial shipowning?

It is recognised that in small ships it is not desirable to reduce scantling, but in large ones where the corrosive effect is relatively small, compared with the thickness of the material, a reduction on the basis of comparative strength could and should be allowed.

I have not dealt with the question of transverse strength as applied to the complete structure. As everything points to the conclusion that we have exaggerated the longitudinal stresses, assuming that the standard set up for the transverse method of construction in vogue to-day is satisfactory, so also have the transverse stresses been exaggerated. My reasons for saying this are as follows: If we have depended more or less successfully upon the longitudinal material embodied in outside shell, tank-top and deck plating, and three, four or five girders to provide the longitudinal strength for a hull of 300 ft., 400 ft., 500 ft., 600 ft. long, in which the standard bending moment is of the nature $\frac{L \times W}{35}$, then the outside shell, tank-top and deck plating reinforced with floor or girder members on the bottom and sectional-beam members in the top, must furnish a degree of strength greatly in excess of the requirements when the girder is 50 ft., 60 ft., 70 ft., 80 ft. long, and the bending moment must be a fraction of $\frac{L \times W}{35}$.

I look upon tank margin attachments as local and not structural, and the nature of the same emphasises my view. The transverse bottom girder formed by the combination of the shell and tank top plating and floors, is suddenly cut, the top flange is practically discontinued, and the break is made good with an ordinary simple riveted attachment, no deeper than the actual girder. Again, the break is in close vicinity to the point of attachment, and consequently one of the points of highest stress in such a girder (Fig. 16). Further than this, I know of a ship having floors 12 ft. apart in the midship body, and giving no trouble. These points satisfy me that the normal design of a plated hull structure will ensure the provision of ample transverse strength.

With regard to water pressures and frame spacing, it has been proved and demonstrated that the frames could be much wider apart or the shell much thinner than has hitherto been the practice, in order to resist any water pressure to which a ship is subjected. Owing to the necessary development of the plating in the transverse ship to resist structural stresses, increased frame spacing has not been considered permissible without a material increase in the plating thickness. In Isherwood ships, 30-in. spacing of longitudinal frame members, with a reduction in the thickness of plating, is the practice and proves satisfactory. I do not refer to the parts of the hull subject to panting and thrashing damage, which is again local, and not structural. Here ample stiffening and weight of material is absolutely essential.

We have seen that the principle of ship construction has remained the same since the introduction of steel, with the exception of the Isherwood and Millar systems. Alterations that have taken place in design have been due to commercial pressure rather than scientific investigation. Why is this? I suggest, with due appreciation of my rashness, that tabulated rules are greatly responsible for discouraging individual examination by naval architects and draughtsmen. In saying this, I recognise and appreciate the great value of tabulated rules prepared by the classification societies, and the facility with which they can be applied. They are much more elastic and administered with a broader outlook than was the case a few years ago, but I still think it would be well to adopt a published standard of strength, leaving greater scope for achievement of that standard to the individual designer.

As the standard of the structure is practically entirely dependent upon loads, I would make reference to the

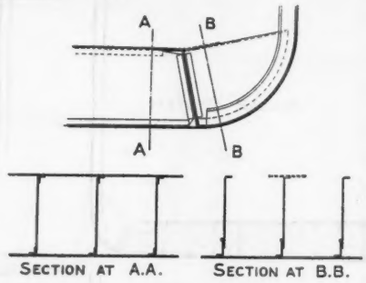


FIG. 16. TYPICAL DOUBLE BOTTOM SHOWING TANK MARGIN ATTACHMENT.

question of scantling relative to displacement coefficient. We have now arrived at the stage where strength and scantling relative to draught are taken into consideration, and we can design a ship in which scantlings are less than the highest standard to obtain a freeboard greater than the minimum. In arriving at the draught, no account is taken of the displacement coefficient, and this, I suggest, is not in keeping with the scientific progress claimed for the proposed new tables. I can imagine a ship having a freeboard determined presumably upon a strength basis, in which it would be considered pure heresy to ask for another 1 in. in draught, where the maximum increased load would be only 60 tons, and the reserve buoyancy still ample, although no objection would be raised to an increase in displacement coefficient say from 0·74 to 0·78, representing an increased load of probably 900 tons.

Summarising my comments, and taking it for granted that economy in initial cost, structural strength and operating efficiency are in the interests of the shipbuilder, shipowner and the general community alike, I feel justified in saying that these important features are most certainly obtained by the construction embodying the highest form of correct structural design, in which the bottom and top sides are stiffened against longitudinal bending by the introduction of closely-spaced sectional material in a longitudinal direction, and the sides are stiffened against deflection, buckling and shearing by closely-spaced vertical sectional members. In addition to the technical accuracy of the design, it ensures the maximum deadweight, entails the minimum amount of shipyard labour, and provides a ship in which the holds are clear of unusual obstructions.

In closing, I would ask you to endeavour to imagine what your views would be to an exact reversal of the above conclusion; if longitudinal framing at the upper and lower members, in conjunction with vertical side framing, had been the established practice, and I suggested the adoption of transverse framing, in which the deadweight would be reduced, the theoretical and actual strength less, and in which frame turning and labour were greater.

STINNES AND SOUTH AFRICAN STEEL INTERESTS.—There are rumours afloat, says *The South African Mining and Engineering Journal*, that Mr. Hugo Stinnes, the German steel magnate, is about to interest himself in certain Union steel interests, in which connection the Union Steel Corporation of South Africa, Limited, and Pretoria Iron and Steel Works, Limited, are prominently mentioned. Inquiries at headquarters have elicited neither confirmation nor denial of such reports. It may, however, be said that Mr. Hugo Stinnes and his consortium have for some time past directed much of their energy and capital from the Fatherland to more settled countries. Furthermore, they have both the ability and the requisite capital to carry out their designs.

CATALOGUES.

Oil Engines.—An interesting series of views of their workshops, of a completed six-cylinder marine engine and of a handsome four-masted yacht fitted with one of their marine engines, has come to hand from Messrs. Vickers-Petters, Limited, Ipswich.

Hammer Drift.—A leaflet describing a tool comprising a taper drift and a self-contained hammer, which can be operated with one hand, for removing taper shank drills and other similar tools from their sockets, is to hand from Mr. J. D. Shackman, 38, Blandford-street, London, W. 1.

Punching Machines.—Two catalogues to hand from Messrs. Pels, 41, Great Marlborough-street, London, W. 1, contain illustrations and particulars of punching, shearing and similar machines; one catalogue relates to power-driven machines and the other to hand-lever types.

Electric Overhead Lines.—A catalogue of all the parts and fittings required for erecting electric power transmission lines on wooden or steel poles, and also containing much useful technical information on the subject, is to hand from British Insulated and Helsby Cables, Limited Prescot, Lancs.

Steel Shelving, &c.—Component parts, such as slotted bars, brackets, corner pieces, &c., for erecting shelving, tables, pipe supports, racks for materials, &c., are illustrated in a catalogue received from Messrs. Constructors Trading Company, Limited, 4, Brook-street, St. Pauls, Birmingham.

Steam Engines.—A catalogue of fixed horizontal steam engines fitted with automatic expansion gear is to hand from Messrs. Robey and Co., Limited, Lincoln. A full specification is given, and a table is included giving the main dimensions, outputs and other data of 10 standard sizes developing up to 256 b.h.p.

Varnishes and Enamels.—Messrs. Jenson and Nicholson, Limited, Stratford, London, E. 15, have sent us copies of new editions of two of their catalogues of varnishes, japans and enamels for general industrial work, such as tin plate printing; coating silk, tarpaulins, wood, iron, &c., and for electrical insulating. Both publications contain much useful practical information relating to the application of the firm's products.

Oil-Break Switches.—A new catalogue of oil-break switches for medium duty, containing full descriptive matter and detail illustrations, is to hand from the English Electric Company, Limited, Kingsway, London, W.C. 2. The construction, operation, safety devices and applications of the switches are clearly dealt with in the catalogue, which forms an excellent example of what this class of publication should be.

Reinforced Concrete.—A volume containing 360 pages of illustrations of reinforced concrete work done and in course of execution in building, tunnelling, piling, bridge building, road making, floor laying, &c., has been received from the British Reinforced Concrete Engineering Company, Limited, 1, Dickinson-street, Manchester. The publication is interesting as it shows the great variety of structural work to which reinforced concrete is now applied.

Marine Oil Engines.—A 100-page catalogue of British Kromhout marine oil engines, issued by Messrs. Perman and Co., Limited, 82, Fenchurch-street, London, E.C. 3, gives a very complete account of the construction and operation of these engines, and also includes some matter on the relative financial and other merits of steam and oil engines for marine service. The illustrations include a large number of views of sea-going and river craft equipped with these engines.

Metal Sawing.—The improvements in high-speed sawing described in a catalogue received from Messrs. Edward G. Herbert, Limited, Levenshulme, Manchester, include a patent saw blade in which the tooth set is impressed in the blade for some distance so that the teeth may be repeatedly sharpened without re-setting, a grinding machine specially constructed for sharpening saw blades and a powerful sawing machine capable of heavy work at high speed. Considerable economy in running cost is claimed for the process.

Switch Gear.—A catalogue of ironclad control gear for direct-current motors, including panels of the drum, multiple lever, solenoid and variable speed types is to hand from Messrs. Brookhirst Switchgear, Limited, Chester. A wide range of gear is dealt with, specifications, dimensions, prices and other necessary information being given in all cases. Many applications of controls to the driving of machine tools, including acceleration and variable speed arrangements, are illustrated and described, together with the safety devices embodied in the designs.

Portable Drilling Machines.—A class of drilling machine which is capable of service under a very wide range of conditions is the portable universal drilling machine developed by Messrs. William Asquith (1920), Limited, of Halifax. The smaller size of this machine we illustrated recently in our columns (see page 266 *ante*). The range of work these machines are capable of performing is well illustrated in a catalogue received from Messrs. William Asquith. This book is excellently got up and lavishly illustrated. The machine is so versatile that a large number of pictures is needed to convey an idea of its possibilities. These are most excellently depicted in the views given of the machine in various positions, and of different sizes, contending with awkward jobs and angle drilling under difficult conditions. The ability to take a drill capable of heavy duty to a work which is too bulky to get to the standard radial machine increases enormously the range of work these drills can tackle.